1915

Copper

Ferdinand Friis Hintze

COPPER

By F. F. Hintze, Jr.

The copper industry of the world during 1914 failed to reach the 1,000,000-ton mark which was somewhat exceeded during the preceding 2 years, and fell back to a level of production slightly below that of 1909, with a decrease of about 7.5 per cent., as compared with figures for 1913. The American rate of production for 1913 continued for the first 7 months of the past year with some increase, but with the beginning of the European war, which interfered at once with the foreign consumption, and especially that of Germany, which is one of the largest importers of copper, came a marked curtailment in output. The final figures for the year, however, are better than had been expected from the reported 50 per cent. decrease of production by the chief concerns, following the outbreak of the war. This cut of one-half was based on the rate of production in July, which was considerably above the average for 1913, so that the total production for the year fell but moderately below that of the preceding year. Had there been no curtailment from unforeseen causes, such as those imposed by the war, 1914 would have been the banner year for copper.

Since 1903 the United States has furnished over half of the world's output of copper, the percentage for 1914 being 56.4, as compared with 55.3 per cent. in 1913.

These figures indicate a relative increase for the United States over the combined production of all other countries during the past year, the decrease in the total production being borne largely by foreign states. Of this decrease, the United States has suffered to the amount of 44 per cent. whereas other countries contributed to the extent of 56 per cent. These comparative results may be otherwise stated, as follows: of the total decrease in world production of 7.5 per cent., 3.3 per cent. was borne by the United States and 4.2 per cent. by the other countries. This amounts to a decrease in production during 1914 of 7.3 per cent. for this country, as against 11.5 per cent. for other countries, as compared with the output of the preceding year. When thus combined with the high production figures of the first half of the year the actual curtailment of production appears to be small, but when the output of the last half of the year is considered separately the great reduction in the rate of production becomes more apparent.

In the following table the normal monthly output of more than 20 of the leading copper producers may be compared directly with the curtailed production of each company for 3 months, beginning August 1, 1914.[1]

Mines or Group.	Output Reduced, Per Cent.	Normal Monthly Output, Lb.	Curtailment 3 Months, Lb.
Anaconda	50	20,000,000	30,000,000
Utah Copper Co.	50	13,200,000	19,800,000
Ray Con	50	6,200,000	9,300,000
Chino	50	5,000,000	8,700,000
Nevada Con	50	4,800,000	7,200,000
Miami	50	3,200,000	4,800,000
Greene-Cananea	100	3,500,000	10,500,000
East Butte	100	1,250,000	3,750,000
North Butte[2]	50	2,300,000	5,200,000
Calumet & Arizona	50	5,700,000	8,400,000
Shattuck	50	1,200,000	1,800,000
Phelps-Dodge	25	12,000,000	9,000,000
Old Dominion	25	1,000,000	2,250,000
United Verde	33	3,000,000	3,000,000
Tamarack	100	500,000	1,500,000
Tennessee	33	1,500,000	1,500,000
U. S. Smelting Co	50	1,700,000	2,500,000
Mountain	100	750,000	2,250,000
Granby	50	3,300,000	4,950,000
Calumet & Hecla	20	10,000,000	6,000,000
Copper Range	50	4,000,000	6,000,000
Quincy	50	2,000,000	3,000,000
Miscellaneous and imports	.....	30,000,000	15,000,000
Total	.....	138,900,000	166,400,000

The departure from the normal output amounts to an average of 40 per cent. for the companies listed, which is evidently somewhat too high a figure to be used as the curtailment factor for the whole of the last half year. The percentage of reduction in the case of many important producers did not become effective at once, and the high rate of production during the first 6 months of the year also tended to minimize the effect of the curtailment policy on the total production for the year. However, as an index to the probable output of the coming year, providing present conditions continue, the above curtailment factor of 40 per cent. may not be much too great.

The smelter production from American and imported ores and scrap during 1914 amounted to 1,398,484,346 lb. of copper as, compared with 1,516,796,972 lb. for 1913. Nearly all of this crude copper went to American refineries along with 131,125,076 lb. of imported crude copper, so that the refiners received a total of 1,492,843,502 lb. from all sources. The following table shows the smelters' production for the past 4 years, together with the deliveries to American refineries during that period:

[1] *Min. Eng. World*, Nov. 14, 1914.
[2] Closed for 6 weeks; then operating 50 per cent.

SMELTERS' PRODUCTION
(In pounds)

Source.	1911.	1912.	1913.	1914.
N. American ore	1,284,932,019	1,489,176,562	1,438,565,881	1,327,488,479
Foreign ore	34,392,091	53,701,307	55,803,202	50,101,308
Scrap	18,529,547	11,949,348	22,427,889	20,894,559
Totals	1,337,853,657	1,554,827,217	1,516,796,972	1,398,484,346
To foreign refiners	32,413,440	45,735,673	36,682,605	36,765,920
To American refiners	1,305,440,217	1,509,091,544	1,480,114,367	1,361,718,426
Crude copper imported	146,422,851	144,480,144	169,315,869	131,125,076
Total crude copper	1,451,863,068	1,653,471,688	1,649,430,236	1,492,843,502

The copper production of the several states for the last 6 years is given in the following table:[1]

COPPER PRODUCTION OF THE UNITED STATES
(In pounds)

State.	1909.	1910.	1911.	1912.	1913.	1914.
Alaska	4,057,142	5,008,171	19,412,000	32,602,000	24,452,000	24,288,000
Arizona	292,042,829	299,606,971	300,578,816	357,952,962	399,849,745	387,978,852
California	53,357,451	45,793,894	36,806,762	31,069,029	32,390,272	29,515,488
Colorado	10,487,940	10,127,012	8,474,848	7,502,000	7,670,090	10,104,579
Idaho	7,770,010	6,216,461	3,745,210	5,964,542	8,434,028	4,856,460
Michigan	227,247,998	221,400,864	216,412,867	231,628,486	159,437,262	157,089,795
Montana	313,838,203	286,242,403	271,963,769	309,247,735	285,336,153	243,139,737
Nevada	51,835,309	63,877,500	65,385,728	82,530,608	84,683,961	60,078,095
New Mexico	5,134,506	3,632,351	1,518,288	27,488,912	46,953,414	64,338,892
Utah	100,438,543	125,042,381	138,336,905	131,673,803	147,591,955	153,555,902
Wyoming	89,654	180,861	.....	1,121,109	448,805	165,023
Southern States	22,837,962	18,195,450	19,656,971	18,592,655	24,333,014	19,213,965
Other States	3,746,895	925,664	1,564,207	4,396,667	4,155,135	4,257,088
Total	1,092,884,442	1,086,249,983	1,083,856,371	1,241,770,508	1,225,735,834	1,092,884,442

The diminished output for the year 1914 was borne in part by all of the states, with the exception of Utah, which shows a slight gain over the output of the previous year. Arizona continued to hold first place in production, with Montana, Michigan, and Utah following in descending order. In all of these states a marked increase for the year would have been realized had it not been for the curtailment which became necessary in consequence of the business depression resulting from the war. In the case of Utah the increase during the first half of the year was more than sufficient to compensate for the curtailed production during the latter part of the year, with a small increase for the year. Michigan was just recovering from the effects of the protracted labor troubles which menaced her mining operations so seriously during the previous year, when she was again hampered by the crumbling of the copper market and general stagnation of business resulting from the European war. Montana's produc-

[1] *Eng. Min. Jour.*, Jan. 9, 1915.

tion was the smallest for several years in spite of the hopeful outlook at the opening of 1914. Labor difficulties between two factions of the miners' union broke out before the middle of the year and caused the first decrease in output, but as the effects of the war began to be felt throughout the country all of the operating companies at Butte curtailed their production to the extent of 50 per cent., so that for the last 5 months of the year the state's production was practically one-half that of the first 6 months of the year.

The fifth greatest copper-producing state in 1914 was New Mexico, Nevada coming sixth. Notwithstanding the war and the curtailment of production which was also felt in New Mexico, that state showed an increase for the year of about 35 per cent., due chiefly to the large-scale operations of the Chino Copper Co., at Santa Rita. Nevada had an exceedingly poor year, showing a decline of almost 25,000,000 lb. in production, brought on chiefly by the curtailment during the latter half of the year as a result of the war.

The reports of the American smelters give the production of copper for the copper-producing countries of North America during 1914 as follows:

SMELTERS' PRODUCTION OF COPPER IN NORTH AMERICA
(In pounds)

Country.	1911.	1912.	1913.	1914.
United States	1,083,856,371	1,241,770,508	1,225,735,834	1,158,581,876
Canada	56,370,754	75,425,575	76,796,586	75,015,758
Mexico	136,430,331	162,295,545	128,579,656	80,108,165
Cuba	8,274,563	9,684,934	7,453,805	13,782,680
Totals	1,284,932,019	1,489,176,562	1,438,565,881	1,327,488,479

The output of Mexico has suffered a further reduction of nearly 40 per cent. as a combined result of the European war and the continuation of the revolution. Since 1912 the copper production of Mexico has fallen off over 50 per cent. At first the industry was affected by internal conditions and a marked decline in production was the direct result of internal warfare, and though the last year has not seen the restoration of proper conditions for the resumption of normal production, the failure of the copper market during the latter half of the year is probably responsible for a large part of the 40 per cent. diminution of last year's output.

The total production of new refined copper in 1914[1] was 1,533,781,394 lb., of which 323,358,205 lb. was produced from foreign, and 1,210,423,189 lb. from domestic, sources.[2] There was also produced during the year from secondary sources 31,926,980 lb. of refined copper, making a total

[1] Advance statement, U. S. Geol. Surv.
[2] The distribution of refined copper of domestic and foreign origin is merely approximate.

of 1,565,708,374 lb. of refined products for the year. The production of refined copper according to class for the last few years is shown in the following table.[1]

PRODUCTION OF COPPER IN UNITED STATES ACCORDING TO CLASS
(In pounds)

Year.	Lake.	Electrolytic. (*d*)	Casting. (*d*)	Pig Copper. (*a*)	Total.
1907	220,317,041	854,441,000	47,957,890	30,032,000	1,152,747,931
1908	222,267,444	850,660,325	44,967,250	35,000,000	1,152,895,019
1909(*e*)..	226,602,134	1,101,518,458	67,471,446	43,159,018	1,438,751,056
1910(*f*)..	221,400,864	1,151,624,597	(*g*)55,673,196	46,903,463	(*g*)1,475,602,120
1911	216,412,867	1,156,627,311	22,977,534	35,920,626	1,431,938,338
1912	231,628,486	1,288,333,298	24,777,266	37,181,237	1,581,920,287
1913(*b*)..	155,715,286	1,037,360,178	44,966,222	36,004,986	1,652,290,541
1914(*b*)..	158,009,748	1,019,276,001	25,730,377	39,334,043	1,565,708,374

(*a*) Exported. (*b*) Advance statement, U. S. Geol. Surv. (*c*) Partly estimated. (*d*) Included copper from scrap and junk. (*e*) The statistics for 1909 are officially communicated to us by the Copper Producers' Association, except that to its report of 34,123,446 lb. of casting copper we have added 33,348,000 lb. reported to us by the junk smelters. The term "Lake" copper is here used to designate all copper sold in the trade as such, regardless of the process by which it is refined. (*f*) Copper Producers' Association, through *Eng. Min. Jour.*, May 6, 1911. (*g*) Includes 23,480,000 lb. from scrap.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of 224 million lb. of copper in the form of brass and other alloys, making a total production of approximately 256 million lb. from secondary sources. Of this material at least 80 million lb. was produced by remelting clean scrap produced in the process of manufacture of copper and brass articles. If the output of plants producing only secondary material is added to the production of the regular refineries, the contribution of domestic plants of the United States to the world's supply of copper for 1914 is found to be 1789 million lb.

Consumption.—The following tabulation gives the estimated consumption of copper in the principal countries of the world during the 3 years preceding 1914.

The Copper Producers' Association suspended the publication of its valuable monthly statistics on copper at the outbreak of the war, and on January 13, 1915, voted to discontinue its organization. This action is much to be regretted as the accurate statistics of the Association have formed the most complete summary of production, refiners' output, and exports of copper in this country during the 5 years of that organization's existence. From the data given in the table the visible supply of copper in the hands of the producers from month to month was known to the consumers, and was a valuable gauge to the producers themselves in regulating the output so as not to overstock the market. Had the consumers furnished a set of figures each month indicating their stocks of

[1] Owing to some uncertainty as to the counting of copper regained from scrap it is unsafe to draw fine deductions from this table.

raw material the rate of production could have been absolutely controlled to suit the demand. Even without the consumers' data the benefits to the copper industry of the concerted action on the part of the producers are clearly indicated by the way the extremely difficult situation resulting from the war was handled whereby an impending crisis was quickly avoided.

WORLD'S CONSUMPTION OF COPPER
(Metric tons)
(From statistical report of the Metallgesellschaft, Frankfurt am Main)

Europe.	1911.	1912.	1913.
Germany	222,500	231,700	259,300
Great Britain	159,100	144,700	140,300
France	95,700	98,500	103,600
Austria-Hungary	38,500	48,200	39,200
Russia	32,800	40,000	40,200
Italy	29,400	34,200	31,200
Belgium	13,500	15,000	15,000
Netherlands	1,000	1,000	1,000
Other European countries	10,000	10,200	(a)13,300
Total consumption in Europe	602,500	623,500	643,100
America			
United States	321,900	371,800	348,100
Others in America	3,000	3,000	3,000
Total consumption in America	324,900	374,800	351,100
Asia, Australia, Africa			
Production Japan and Australia	95,000	111,900	119,000
Imports from Europe	500	1,400	1,000
Imports from America	.....	500	80
Total	95,500	113,800	120,100
Exports to Europe and America	68,800	74,300	69,800
Consumption in Asia, Australia and Africa	26,700	40,400	50,300
World's consumption	954,100	1,038,700	1,044,500
World's production	893,800	1,018,600	1,005,900

(a) Estimated.

The following table gives the figures of the Copper Producers' Association, together with those of Henry R. Merton & Co. relating to production, deliveries for domestic consumption and foreign use, and visible stocks in the United States and Europe, as far as they have been issued by the respective organizations for the years 1913 and 1914.

The domestic supply of salable copper on Jan. 1, 1914, was 91,438,867 lb. and the stocks of refined copper on hand at the plants of the refineries on Jan. 1, 1915, was 173,640,501 lb.[1] The production of refined copper during 1914 was 1,565,708,374 lb., which, combined with the domestic supply at the beginning of the year, makes an available supply of 1,657,-147,241 lb. for the year. This compares with 1,727,763,411 lb. for 1913. During 1914 there was exported 840,080,922 lb. of all classes of refined copper, which, subtracted from the total available supply, leaves 817,066-319 lb. on hand for home consumption. After deducting the supply on

[1] Advance statement, U. S. Geol. Surv.

hand Jan. 1, 1915 from the domestic supply, the apparent home consumption amounted to 643,425,818 lb. This compares with 709,978,402 lb. in 1913.

Month.	United States.			Visible Stocks.		
	U. S. Refin'y Production.	Deliveries, Domestic.	Deliveries, for Export.	United States.	Europe.	Total.
Year, 1912....	1,581,920,287	819,665,948	746,396,452	.....	.....	.....
I, 1913.....	143,479,625	65,210,030	60,383,845	105,312,582	78,491,840	183,804,422
II.....	130,948,881	59,676,492	72,168,523	123,198,332	77,504,000	200,702,332
III.....	136,251,849	76,585,471	77,699,306	122,302,890	81,244,800	203,547,690
IV.....	135,353,402	78,158,837	85,894,727	104,269,270	87,180,800	191,450,070
V.....	141,319,416	81,108,321	68,285,978	75,549,108	85,948,800	161,497,908
VI.....	121,860,853	68,362,571	68,067,901	67,474,225	77,235,200	144,709,425
VII.....	138,074,602	58,904,192	78,480,071	52,814,606	71,904,000	124,718,606
VIII.....	131,632,362	73,649,801	73,263,469	53,594,945	66,420,480	120,015,425
IX.....	131,401,229	66,836,897	73,085,275	38,314,037	63,716,800	102,030,837
X.....	139,070,481	68,173,720	68,123,473	29,793,094	53,625,600	83,418,694
XI.....	134,087,708	48,656,858	70,067,803	32,566,382	48,787,200	81,353,582
XII.....	138,990,421	21,938,570	73,542,413	47,929,429	46,592,000	94,521,429
Year, 1913....	1,622,450,829	767,261,760	869,062,784	.....	.....	.....
I, 1914.....	131,770,274	47,956,955	87,955,501	91,438,867	53,916,800	145,355,667
II.....	122,561,007	47,586,657	83,899,183	87,296,685	50,108,800	137,405,485
III.....	145,651,982	69,852,349	89,562,166	78,371,852	47,376,000	125,747,852
IV.....	151,500,531	63,427,633	82,345,216	64,609,319	46,435,200	111,044,519
V.....	142,308,287	55,592,170	72,710,477	70,337,001	52,371,200	122,708,201
VI.....	141,345,571	46,227,353	73,350,196	84,342,641	61,062,400	145,405,041
VII.....	.....	.....	.....	106,110,663	64,220,800	170,331,463
VIII.....	.....	.....	.....	.....	66,499,880	.....
IX.....	.....	.....	.....	.....	*68,277,440	.....
X.....	.....	.....	.....	.....	*66,234,560	.....
XI.....	.....	.....	.....	.....	*73,059,840	.....
XII.....	.....	.....	.....	.....	†49,817,600	.....

* German stock estimated.
† German stock omitted.
Note.—Visible supplies in Europe do not include copper afloat.

In the following table the consumption of refined copper is approximately shown for the past 10 years.

CONSUMPTION OF COPPER IN THE UNITED STATES (*a*)

Year.	Production.	Stock Jan. 1.	Imports.	Supply.	Exports.	Stock Dec. 31.	Consumption.
1905...	875,241,741	208,376,672	210,724,685	1,294,343,098	548,772,403	132,587,496	612,983,199
1906...	917,620,000	132,587,496	225,593,281	1,275,800,777	467,839,041	139,385,400	668,576,336
1907...	1,152,747,890	9,000,000	5,000,000	1,166,747,890	508,929,401	120,000,000	537,818,489
1908...	1,152,895,019	120,000,000	.....	1,272,895,019	661,876,127	122,357,266	488,661,626
1909...	1,405,403,056	122,357,266	.....	1,527,760,322	682,846,726	141,766,111	703,147,485
1910...	1,452,122,120	141,766,111	.....	1,593,888,231	708,316,543	122,030,195	763,541,493
1911...	1,431,938,338	122,030,195	.....	1,553,968,533	786,553,208	89,454,695	677,960,630
1912...	1,581,920,287	89,454,695	.....	1,671,374,982	775,000,658	105,312,582	791,061,742
1913...	1,622,456,829	105,312,582	.....	1,727,769,411	926,441,142	91,348,867	709,979,402
1914(*b*)	1,565,640,501	91,438,867	.....	1,657,147,241	840,080,922	173,640,501	643,425,818

(*a*) The statistics in the above table up to 1906 inclusive are computed in the old way, namely, on the basis of the production of blister oopper and the imports of copper in all forms. The stock on hand at the beginning and end of the year includes not only refined copper, but also the crude copper in transit and in process of refining. The statistics since 1906 are computed on the new and more accurate method described in *Eng. Min. Jour.*, July 25, 1908. Briefly, in this method the basis is production of refined copper, stock of copper in final marketable form and imports of refined copper. This change in method explains the erratic appearance of the figures for 1907 as compared with those of 1906. (*b*) U. S. Geol. Surv. estimate.

The sum of Production, Stock Jan. 1, and Imports is the Supply. The Exports are different from deliveries for Export, and are obtained from the statistical report of the Department of Commerce. The Supply less the Exports and the Consumption gives the stock Dec. 31.

Deliveries of refined copper by quarters are shown in the following table for the years 1909 to 1914, inclusive, both for domestic and foreign consumption. The amounts for the different 3-month periods differ

DELIVERIES OF COPPER

Year.		Domestic.	Foreign.
1909	I	144,312,706	128,659,336
	II	169,300,451	206,619,321
	III	187,240,245	173,479,455
	IV	202,736,991	171,074,403
1910	I	207,621,527	159,646,957
	II	180,654,369	142,723,782
	III	188,940,464	196,345,443
	IV	172,210,182	223,715,303
1911	I	158,678,344	157,400,885
	II	178,607,174	195,568,675
	III	174,229,530	195,560,329
	IV	198,096,557	206,372,344
1912	I	186,059,735	202,095,566
	II	208,362,352	184,187,921
	III	213,277,609	190,871,277
	IV	211,966,252	169,241,688
1913	I	201,471,993	210,251,674
	II	227,629,729	222,248,606
	III	199,390,890	224,828,815
	IV	138,769,148	211,733,689
1914	I	165,395,961	261,416,850
	II	165,247,156	228,405,889

considerably, and if a table were prepared showing the variations from month to month the departures would be still more conspicuous. However, when the yearly deliveries are considered there is a steady increase noticeable, especially in the case of foreign takings. It is interesting to note that the domestic consumption has lately been smaller than at any time during the last few years, while the foreign deliveries have continually increased and are at present far in excess. This seems to indicate a more liberal use of copper among foreign countries, especially in Germany.

There is great variation from one quarter to the next in the deliveries, both for home as well as foreign consumption. The use of copper by the manufacturers is probably very steady, but is entirely different from the deliveries made by the refiners, since these are made only when the manufacturer wishes to replenish his stock. This accounts for the erratic character of the data from quarter to quarter, and at the same time explains the steady increase in consumption from year to year as the uses for copper have multiplied. If the figures were complete for the year

1914, the foreign deliveries would show a heavy decrease in the fourth quarter, on account of the chaotic condition of the export trade as a result of the war, while the domestic consumption would probably be nearly uniform.

Exports.—According to the Bureau of Foreign and Domestic Commerce, the exports of copper ore, matte, and regulus from the United States during 1914 was as shown in the following table.

EXPORTS OF COPPER FROM THE UNITED STATES (*a*)
Ore, matte and regulus stated in tons of 2240 lb. Ingots, etc., in pounds.

Country.	1909.	1910.	1911.	1912.	1913.	1914.
Ore, matte and regulus	59,880	43,784	57,915	66,171	65,684	43,529
Ingots and scrap (*b*) Exported to:						
United Kingdom....	156,511,113	98,030,213	108,061,603	95,422,292	33,679,641	198,382,459
Belgium.....	6,016,861	7,176,258	5,125,004	7,674,273	7,102,120	5,429,717
France.....	99,003,962	116,193,850	135,038,893	131,362,694	160,000,345	150,839,897
Germany.....	138,213,290	175,861,028	190,428,008	252,156,012	307,150,761	176,698,948
Italy.....	26,386,069	34,110,237	38,216,773	47,251,432	41,568,713	67,415,944
Netherlands.....	204,378,211	221,764,806	230,693,649	152,618,177	178,940,289	126,001,150
Russia.....	3,519,216	6,848,311	15,601,688	4,961,473	7,907,672	8,731,272
Austria Hungary...	.....	.....	44,200,202	38,558,151	34,648,205	26,989,548
Other Europe.....	41,661,979	42,203,861	9,254,363	8,960,973	14,357,014	45,634,229
Brit. North America	6,790,410	5,628,487	8,931,582	30,302,856	36,182,257	24,221,498
Other countries.....	319,328	499,492	1,001,443	5,732,325	4,904,125	9,736,260
Total.....	682,846,726	708,316,543	786,553,208	775,000,658	826,441,142	840,080,922

(*a*) The exports of ore, matte and regulus are reported as gross weight, the copper contents not being stated. (*b*) Includes bars and plates.

The figures indicate the greatest shipments of copper to Great Britain during 1914 that have occurred for many years, probably on account of the increased demand for copper created by the war. In contrast with this increase is the decided falling off in the shipments to Germany, also chargeable to the effects of the European war. Early in the conflict England adopted a policy to prevent all shipments of copper from reaching Germany by placing copper on the contraband list, and even went farther than that, detaining several shiploads that were consigned to neutral nations. Through these drastic measures England virtually stopped all copper shipments to the rest of Europe, excepting France, and brought on the conditions that have so materially affected the copper industry of this country. Up to January 1, 1915, 31 shipments of copper to neutral Continental ports were seized by Great Britain. These seizures aggregated 19,350 tons, of which 9350 tons was piled up at Gibraltar alone. Four of the shipments were destined for Holland, 14 for Italy, and 13 for Sweden.[1] In spite of representations made by our government, England refused to permit copper shipments to proceed to neutral ports, and American owners of the copper agreed to sell their products

[1] New York *World*, Feb., 1915.

to the British government at a reduced rate, rather than institute prize-court proceedings, which are always protracted and expensive.

Imports.—According to the report of the Bureau of Foreign and Domestic Commerce, the copper imported in the form of ore, matte, and regulus during 1914 was 104,801,324 lb. net; and in the form of pigs, bars, ingots, plates, and scrap was 201,549,503 lb. These figures are less in both instances than those of 1912 and 1913, as seen in the accompanying table. The total value of the imported copper in 1914 is estimated by the Bureau of Commerce as $39,986,004.

World's Production

Statistics on the world's production of copper as given in the accompanying table are taken mainly from the figures of the *Engineering and Mining Journal* and from those compiled by Henry R. Merton & Co. In all cases the production from domestic raw products and ore only are included, and for the reason that in a few cases some of them may have been exported without recording them, the figures may be low.

IMPORTS OF COPPER INTO THE UNITED STATES (*a*)
(In pounds)

Country.	1909.	1910.	1911.	1912.	1913.	1914.
Ore and matte Imported from:						
Germany	.....	.....	.....	.....	1,067,024	4,684,448
Spain	.....	.....	.....	.....	6,244,676	2,633,395
Cuba	.....	.....	.....	.....	5,362,132	18,659,788
Brit. North America	9,689,829	10,024,806	12,919,644	28,930,073	34,072,096	24,304,104
Mexico	23,914,040	22,731,184	16,684,071	18,069,987	19,722,530	15,495,694
South America	20,987,197	19,425,233	15,305,335	26,749,545	(*c*) 25,311,542	(*c*) 30,562,839
Other countries	26,496,327	33,033,752	23,717,628	31,122,098	17,712,105	8,460,836
Total	81,087,393	85,224,975	68,626,678	104,871,703	109,492,105	104,801,324
Pig and Scrap (*b*) Imported from:						
United Kingdom	26,527,574	18,649,727	9,004,461	1,404,118	17,943,285	5,163,126
Other Europe	27,379,175	25,411,383	28,042,257	31,670,095	(*d*) 36,565,767	(*d*) 16,931,784
Brit. North America	29,196,351	29,016,785	22,442,335	36,138,255	33,749,133	27,230,559
Mexico	76,119,724	84,008,907	97,115,574	124,742,193	97,003,847	43,193,868
Chile	.....	.....	5,175,823	8,627,421	18,315,000	23,814,659
Peru	.....	.....	42,545,031	43,891,439	42,667,436	10,918,069
Australia and Tasmania	.....	.....	22,426,670	24,700,333	22,149,335	44,488,809
Japan	23,830,140	18,482,989	20,030,447	19,511,402	14,367,493	15,130,001
Other countries	55,797,329	83,640,995	19,197,254	14,684,336	17,298,533	14,678,628
Total	238,850,293	259,210,786	265,980,760	305,369,592	300,059,829	201,549,503

(*a*) The imports reported are the copper contents of ore, matte, and regulus. (*b*) Includes also bars, ingots, and plates. (*c*) All from Chile. (*d*) All from Spain.

The effect of the European war on the copper industry of the world can plainly be seen by comparing the production figures of the past year with those of the preceding 2 years. Prospects at the beginning of the year were that all previous records would be broken, and the progress of the first 7 months shows that in all probability that would have been

the case had no interruption occurred. The policy of curtailment adopted by the larger producers, following the outbreak of the war and the consequent slump in the market, caused the output of the last few months to run far below the normal, but the heavy demand for copper for war purposes soon restored the market and the industry gradually got back to average production by the close of the year. However, the excess production of the first 7 months was not sufficient to counterbalance the loss due to curtailment, so that a net loss of 78,496 tons was sustained.

THE WORLD'S COPPER PRODUCTION
(In metric tons)

Country.	1905.	1906.	1907.	1908.	1909.	1910. (*h*)	1911.	1912.	1913.	1914.
Africa (*a*) Cape Co...	5,105	4,003	4,298	4,550	4,720	7,016	17,252	16,633	5,812	3,125
Africa (*a*) Namaqua	2,337	2,642	2,540	2,440	2,337				2,540	2,328
Africa (*a*) Other	.....	.....	.....	.....	8,128	8,433	.....	.....	17,059	18,682
Argentina (*a*).....	157	107	224	226	610	305	1,036	335	117	.....
Australasia (*a*).....	34,483	36,830	41,910	40,123	34,952	40,962	42,512	47,774	47,326	37,592
Austria-Hungary (*a*)	1,346	1,458	1,062	3,877	6,218	2,276	2,566	4,024	4,135	3,310
Bolivia (*a*).....	2,032	2,540	21,035	2,540	2,032	2,540	(*d*) 2,950	(*d*) 4,681	3,658	2,743
Canada (*d*).....	21,595	19,110	2,540	24,376	21,626	23,810	25,570	34,213	34,587	34,027
Chile (*d*).....	29,126	25,829	28,863	42,097	42,726	38,346	33,088	39,204	40,195	40,876
Cuba (*d*).....	.....	1,384	1,388	2,966	3,006	3,538	3,753	4,393	3,517	6,251
Germany—total (*a*).	22,492	20,665	20,818	20,523	32,815	25,105	22,363	24,304	25,309	30,480
(Mansfeld) (*a*) ..	(19,878)	(18,085)	(17,343)	(18,000)	(19,015)	(20,275)	.....	.....	(20,201)	.....
Italy (*a*).....	2,997	2,911	3,353	3,022	2,769	3,272	2,642	2,337	1,626	2,410
Japan (*f*).....	35,944	36,963	40,183	41,399	42,987	50,703	(*d*) 52,303	(*d*) 62,486	(*a*) 73,152	68,058
Mexico—total (*d*)...	65,449	61,615	57,491	38,190	57,230	62,504	61,884	73,617	52,815	36,337
(Boleo) (*a*).....	(10,341)	(11,002)	(11,506)	(12,600)	(12,426)	(13,003)	.....	.....	(13,020)	.....
Newfoundland (*a*)..	2,316	2,332	1,758	1,453	1,402	1,097	1,174	549	.....	.....
Norway (*a*).....	6,406	6,218	7,122	9,337	9,226	10,592	9,576	11,156	11,796	.....
Peru (*e*).....	12,213	13,474	20,681	15,240	16,257	27,375	28,500	(*f*) 26,483	(*d*) 25,715	23,647
Russia (*c*).....	9,515	9,296	15,930	17,718	18,035	22,670	25,747	33,550	42,970	31,938
Spain-Portugal (*a*)..	45,527	50,109	50,470	53,425	53,023	51,080	51,748	59,876	54,696	37,099
Rio Tinto (*a*)....	32,795	34,642	32,833	35,517	35,938	(34,114)	(35,100)	.....	36,901	21,515
Tharsis (*a*).....	4,415	4,816	4,206	4,500	4,425	(3,551)	(3,450)	.....	3,270	.....
Mason & Barry (*a*)	2,764	2,504	2,662	2,804	2,403	(3,003)	(2,972)	.....	3,185	.....
Sevilla (*a*).....	1,300	2,073	2,337	2,196	1,849	(1,656)	(1,558)	.....	1,535	.....
Sweden (*c*).....	1,385	1,209	1,577	2,808	2,032	2,032	2,032	(*a*) 1,524	(*a*) 1,016	.....
Turkey (*a*).....	711	432	1,270	1,068	813	610	1,016	508	508	.....
United Kingdom (*g*)	727	762	677	588	442	508	405	405	305	.....
United States (*d*)...	397,069	416,343	398,930	430,399	501,372	492,720	491,634	563,260	557,387	525,529
Total.....	698,931	715,510	724,120	758,065	854,758	877,494	879,751	1,011,312	1,002,284	923,888

(*a*) As reported by Henry R. Merton & Co., Ltd., of London. (*c*) As officially reported, except for 1909, for which year the figure of Henry R. Merton & Co. is used. (*d*) As reported by the *Eng. Min. Jour.* (*e*) As officially reported 1903–1907, as per Henry R. Merton & Co. for 1908 and 1909. (*f*) As officially reported, (*g*) As officially reported, 1900–1905; subsequently as per Henry R. Merton & Co. (*h*) Henry R. Merton & Co., through *Eng. Min. Jour.*

WORLD'S PRODUCTION OF COPPER (*a*)

Year.	Metric Tons.	Short Tons.	Year.	Metric Tons.	Short Tons.	Year.	Metric Tons.	Short Tons.
1882....	184,620	203,550	1893...	310,704	342,562	1904...	693,240	764,758
1883....	202,697	223,481	1894...	330,075	363,920	1905...	698,931	770,221
1884....	223,884	246,840	1895...	339,994	374,856	1906...	715,510	788,492
1885....	229,315	252,828	1896...	384,493	423,917	1907...	724,120	798,205
1886....	220,669	243,295	1897...	412,818	455,147	1908...	758,065	835,623
1887....	226,492	249,716	1898...	441,282	486,529	1909...	854,758	942,408
1888....	262,285	281,179	1899...	476,194	525,021	1910...	877,494	966,998
1889....	265,516	292,741	1900...	491,435	541,561	1911...	879,751	969,750
1890....	274,065	302,166	1901...	529,508	583,517	1912...	1,011,312	1,114,769
1891....	280,138	308,862	1902...	542,606	597,951	1913...	1,002,284	1,104,517
1892....	309,113	340,808	1903...	630,590	694,910	1914...	923,888	1,018,395

(*a*) The statistics for 1881–1891 are as reported by Henry R. Merton & Co.; 1892–1910 as per MINERAL INDUSTRY.

Price.—The price of copper declined steadily during 1914 from its highest point at the beginning of the year, when electrolytic commanded close to 15 cts., to the lowest price of the year in November, when the price had reached its lowest ebb at 11.10 cts. During the rest of the year the price improved gradually, rising to 13.2 cts. in December, but

AVERAGE PRICE OF ELECTROLYTIC COPPER PER POUND IN NEW YORK (*a*)

Year	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1904.	12.410	12.063	12.299	12.923	12.758	12.269	12.380	12.343	12.495	12.993	14.284	14.661	12.823
1905.	15.008	15.008	15.125	14.920	14.627	14.673	14.888	15.664	15.965	16.279	16.599	18.328	15.590
1906.	18.310	17.869	18.361	18.375	18.457	18.442	18.190	18.380	19.033	21.203	21.833	22.885	19.278
1907.	24.404	24.869	25.065	24.224	24.048	22.665	21.130	18.356	15.565	13.169	13.391	13.163	20.004
1908.	13.726	12.905	12.704	12.743	12.598	12.675	12.702	13.462	13.388	13.354	14.130	14.111	13.208
1909.	13.893	12.949	12.387	12.563	12.893	13.214	12.880	13.007	12.870	12.700	13.125	13.298	12.982
1910.	13.620	13.332	13.255	12.733	12.550	12.404	12.215	12.490	12.379	12.553	12.742	12.581	12.738
1911.	12.295	12.256	12.139	12.019	11.989	12.385	12.463	13.405	12.201	12.189	12.616	13.552	12.376
1912.	14.094	14.084	14.698	15.741	16.031	17.234	17.190	17.498	17.508	17.314	17.326	17.376	16.341
1913.	16.488	14.971	14.713	15.291	15.436	14.672	14.192	15.400	16.328	16.337	15.182	14.224	15.269
1914.	14.223	14.491	14.131	14.211	13.996	13.603	13.223	(*b*)	(*b*)	(*b*)	11.739	12.801	.....

(*a*) From *Eng. Min. Jour.* (*b*) No quotation.

AVERAGE PRICE OF STANDARD COPPER (G. M. B.'s) IN LONDON (*a*)
(In pounds sterling per ton of 2240 lb.)

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1903.....	53.52	57.34	63.85	61.72	61.73	57.30	56.64	58.44	56.82	55.60	56.30	56.36	57.97
1904.....	57.500	56.500	57.321	58.247	57.321	56.398	57.256	59.952	57.645	60.012	65.085	66.375	58.884
1905.....	68.262	67.963	68.174	67.017	64.875	65.881	66.887	69.830	69.667	71.406	74.727	78.993	69.465
1906.....	78.869	78.147	81.111	84.793	84.867	83.994	81.167	83.864	87.831	97.269	100.270	105.226	87.282
1907.....	106.739	107.356	106.594	98.625	102.375	97.272	95.016	79.679	68.375	60.717	61.226	60.113	87.007
1908.....	62.386	58.786	58.761	58.331	57.387	57.842	57.989	60.500	60.338	60.139	63.417	62.943	59.902
1909.....	61.198	57.688	56.231	57.363	59.338	59.627	58.556	59.393	59.021	57.551	58.917	59.906	58.732
1910.....	60.923	59.388	59.214	57.238	56.313	55.310	54.194	55.733	55.207	56.722	57.634	56.069	57.054
1911.....	55.604	54.970	54.704	54.035	54.313	56.368	56.670	56.264	55.253	55.176	57.253	62.063	55.973
1912.....	62.760	62.893	65.884	70.294	72.352	78.259	76.636	78.670	78.762	76.389	76.890	75.516	72.942
1913.....	71.741	65.519	65.329	68.111	68.807	67.140	64.166	69.200	73.125	73.383	68.275	65.223	68.355
1914.....	64.304	65.259	64.276	64.747	63.182	61.336	60.540	(*b*)	(*b*)	(*b*)	53.227	56.841	.....

(*a*) From *Eng. Min. Jour.* (*b*) No quotation.

AVERAGE MONTHLY PRICES OF COPPER MANUFACTURES (*a*)
(In cents per pound)

	1913.		1914.	
	Wire.	Sheet.	Wire.	Sheet.
Jan.....	19.09	23.50	15.94	20.75
Feb.....	16.38	22.50	15.88	20.50
Mar.....	16.39	21.50	15.60	20.35
Apr.....	16.50	21.50	15.25	20.25
May.....	16.50	21.50	15.23	19.90
June.....	16.18	21.10	15.03	19.56
July.....	15.88	20.50	14.88	19.38
Aug.....	16.60	21.50	14.63	18.80
Sept.....	17.84	22.50	14.34	18.00
Oct.....	17.75	22.50	13.34	17.38
Nov.....	17.28	21.15	12.50	17.50
Dec.....	15.79	20.50	14.25	18.88
Year.....	16.85	21.69	14.74	19.24

(*a*) *Eng. Min. Jour.*

declined again to 12.70 before the close of the year. The average price for the year was about 13.5, as compared with 15.5 for the year 1913. The highest monthly average was recorded in February, at 14.49, and the lowest monthly average occurred in November, at 11.74 cts. During the first half of the year the price held up to an average of 14.11 cts. in spite of the heavy rate of production, but after the outbreak of the war the market soon became overstocked and the price dropped rapidly to the lowest mark recorded for more than 10 years.

Copper Mining in the United States

Alaska.—The production of copper in Alaska during 1914 shows a slight increase over that of the previous year in spite of the discouraging conditions of the copper market during the latter part of the year. The smelter production figures show that 24,985,847 lb. of copper was recovered during the year, as compared with 23,423,070 lb. in 1913.[1] The developments made up to midsummer gave promise that 1914 would be the most profitable year in the history of Alaska copper mining, but the financial stringency and the collapse of the copper market that followed the breaking out of the European war not only closed down some of the producing mines, but also put a stop to some very important developments. Up to about the first of August seven copper mines were in steady operation, but at the close of the year only three were still working. Had it not been for the war, at least nine copper mines would have been ready to ship ore before the end of the year. Probably the most important events of the year to the copper industry were the re-opening of the Mamie mine, in the Ketchikan district; the installation of a shipping plant, and the opening of the Midas mine, near Valdez; and the completion of aerial trams at the Jumbo and Mother Lode mines, in the Chitina district.[2]

The Kennecott Mines Co. curtailed its production to such a point that at the end of the year it was not operating its concentrator, but merely shipping high-grade ore from the Bonanza and Jumbo mines, which were each working at about half capacity. The Jumbo, which began producing regularly in December, proved to be equal to the Bonanza itself, or to surpass it both in richness and in quantity.

Among the other companies the Mother Lode continued active operations and made some valuable discoveries during the year. The Hubbard-Elliot continued its work, and the same is true of the Alaska Consolidated, the Great Northern, and the Rarus group.

In and around Prince William Sound two copper mines were operated.

[1] Advance statement, U. S. Geol. Surv.
[2] Mining in Alaska in 1914, A. H. Brooks, *Salt Lake Min. Rev.*, Jan. 30, 1915.

The Beatson Copper Co., on Latouche Island, almost completed its new concentrator from which production was expected to begin early in 1915. This mill embraces both gravity and flotation methods. New concentrate bins and docks provided with a conveyor belt for loading were erected. The mill is connected with the mine by means of a 2000-ft. tunnel, but mining is done in an open cut. About 50,000 tons was mined and shipped during the year.

The Ellamar Co. during the year completed an aerial tramway connecting its shaft bins with deep water loading facilities and having a capacity of 200 tons per hour. The discharge station is 2200 ft. out in the bay from the loading station, and the system required the erection of six towers. The year's production of the mine is about 30,000 tons, which might have been greatly increased if market conditions had justified.

The Three-Man Mining Co., on Landlock Bay, developed through the year and has several hundred tons of copper ore ready for shipment. No attempts were made to take out ore except as development work required. The property is under option.

Arizona.—During 1914 Arizona maintained its previously acquired rank as the greatest copper-producing state of the Union. The output for the year was somewhat less than that of 1913, but considering the serious interference of the war in the American copper industry during the last half of the year, the production was surprisingly large. The average rate of production was well above 1,000,000 lb. per day for the year, the final total being 387,978,852 lb., as compared with 399,489,745 lb. in 1913. These figures indicate a decrease of a little less than 1,000,000 lb. per month for 1914, and it is safe to say that, had not the war forced upon the principal copper producers a policy of curtailment of production, the output would have been far in advance of that of 1913. Figures for the first seven months of 1914 indicate that during that part of the year the production ran about 30,000,000 lb. ahead of the output for the corresponding months of 1913,[1] and it seems fair to assume that, had nothing intervened, the total for 1914 would have been nearly double that amount, so that the curtailment in Arizona's production probably amounted to nearly 75,000,000 lb.

The Calumet & Arizona Mining Co.'s (Warren, Ariz.) report for 1914 shows a net income of $3,058,536 from all sources, including subsidiary companies. Total receipts were $8,518,998, of which $14,984 came from miscellaneous sources and the remainder from metals produced. Expenditures were $5,303,375 for operations and $130,089 for outside properties. Dividends aggregated $1,851,008. The net cost of refined copper after deducting the value of precious metals was 8.19 cts. per lb.

[1] Copper in Arizona, by James Douglas, *Eng. Min. Jour.*, Jan. 9, 1915.

The value of precious metals was $28.35 per ton of refined copper. The production of refined copper, gold and silver follows:

	Produced from		
	Domestic Ore.	Purchased Ore.	Total.
Pounds copper	49,992,909	2,675,020	52,667,929
Ounces silver	573,606	348,537	922,143
Ounces gold	19,745	4,377	24,122

The Calumet & Arizona mine produced 66,467 dry tons of ore and performed 6328 ft. of development work, which is about 1 ft. for 10.7 tons of ore mined, as compared with 6.8 tons in 1913. The Superior & Pittsburgh mine produced 505,001 tons of ore and performed 66,465 ft. of developmental work, or about 1 ft. for 8 tons of ore.

The smeltery treated 668,776 dry tons of ore, of which 138,725 tons was custom ores. The blast furnaces handled 403,269 tons of ore and 31,299 tons of slag and cleanings. The reverberatory department handled 238,095 tons of charge and the roasting department, with an average of seven furnaces operating, roasted 209,138 wet tons of ore. The average sulphur contents of the ore treated were 27.5 per cent. and the calcines produced contained 9 per cent. sulphur. The converters produced 32,058 tons of blister copper. Siliceous material to the amount of 24,823 tons was treated in the converters.

The one new large-scale project of the year in Arizona is the development of the property of the New Cornelia Copper Co. in the Ajo district.[1] It is controlled by the interests prominent in the Calumet & Arizona Co., and its mining and metallurgy is to be conducted by the staff of that company. The ores are of low grade, part sulphide and part oxidized, and an attempt is being made to extract them by mixing in certain ores of the Calumet & Arizona mines whose ingredients can be applied to the extraction of the Ajo ores.[2]

To develop the New Cornelia property, the ground considered as probably ore-bearing was coördinated with east-west and north-south lines at 200-ft. intervals and drill holes were sunk at the intersections.

After 6 months of drilling, test-pitting was begun for the sake of checking the drilling results. The pits were about 4 by 6 ft. in size, sunk with windlass and hand drills, Mexican and Papago Indian miners being employed. The work was done on contract, and after practice, the men became so efficient that up to a depth of 50 ft., test-pitting was cheaper than diamond drilling. During the last year of development, test pits were sunk 50 ft. deep on the coördinate points in advance of the drilling, in order both to expedite the work and to decrease the drilling cost.

Every tenth bucket hoisted from each hole was taken for a sample and large samples were thus obtained for every round shot. Then after the pit was completed, it was re-sampled in 5-ft. sections by cutting a

[1] For an extended account of the Ajo district, see *Eng. Min. Jour.*, Oct. 10, 1914.
[2] J. Douglas, *Eng. Min. Jour.*, Oct. 10, 1914.

rectangular vertical groove 3 in. deep by 6 in. wide, so as to give about a 500-lb. sample for each 5-ft. section. These channel samples averaged about 0.15 per cent. lower than the bucket samples, and were taken for the final samples of the pit.

In the sulphide ore the pits encountered water, which made sinking so slow that only a few hundred feet was done in the sulphide zone. However, to check more thoroughly the drilling results in the sulphide and prove a constant grade of ore between drill holes, drifts were run on coördinate lines from the bottoms of two of the deepest test pits and raises were put up from these drifts to check the drill holes. For the sake of giving accurate samples the material broken in each round was hoisted separately, dumped on an iron plate, and every tenth shovelful taken out for the large sample to be cut down later.

Up to September, 1913, when development work was stopped, 84 diamond-drill holes had been bored, varying in depth from 200 to 1000 ft. and giving a total footage of 23,097. Of these, 19 were stopped in ore. In all, 77 test pits were sunk with a total footage of 3955; of this, 3606 ft. was in carbonate ore and 349 in sulphide; 1059 ft. of the test pitting checked drill holes in carbonate ore, 175 ft. checked drill holes in sulphide, and 2721 was done in advance of drilling. The drifting in the sulphide ore amounted to 1513 ft. and the combined sinking and raising on drill holes in sulphide ore was 317 ft.

The sinking, drifting and raising checked the drilling accurately. The channel samples of the test pits in carbonate averaged 0.005 per cent. lower than the corresponding diamond-drill samples; the test pits and raises in sulphide averaged 0.05 per cent. lower than the diamond-drill samples; and the drifts in sulphide averaged 0.26 per cent. higher than the assay value of the blocks through which they were run, as indicated by the drill holes at the corners of the blocks. In calculating the ore, drill samples were used wherever drilling was done, and channel samples of test pits were used where sinking was done in advance of drilling. The estimate of the ore developed is as follows:

	Tons.	Copper, Per Cent.
Ore estimate:		
Carbonate	11,954,400	1.54
Sulphide	28,303,600	1.50
Total	40,258,000	1.51
Available by steam shovel:		
Carbonate	11,954,400	1.54
Sulphide	20,526,800	1.54
Total	32,481,200	1.54
Not available by steam shovel:		
Sulphide	7,776,800	1.40
Rock which must be removed to make steam-shovel tonnage available:		
Rock in carbonate zone	708,400	0.65
Rock in sulphide zone	2,600,000	0.63
Total rock	3,308,400	0.63

The gold and silver content is low, generally amounting to less than 15 cts. per ton. In computing the tonnage, no material running under 1 per cent. in copper was included. The estimate of ore available for steam shoveling depends on the assumed maximum grade of track in approaches and pits, and on amount of lean rock in the sides and bottom of the pit which it will pay to remove in order to get access to the ore. It is likely that the proportion removed by steam shovel will be greater than that indicated in the table. Not only will there be no stripping expense, but the absence of overburden precludes the possibility of lowering grades by the admixture of barren material. Both tonnage and content of copper, therefore, should come out closely to the estimate.

The ore-body already developed will supply a 4000-ton mill for over 26 years, or a 6000-ton mill for over 18 years. Indications are that the life of the mine will be greatly lengthened by the development of a large tonnage of deep ore along the fracture zone in the center of the ore-body. For the next quarter of a century, the Ajo will be one of the greatest copper districts of the southwest.

The report for 1914 of the Ray Consolidated Copper Co., Ray, Ariz., shows a production of 57,004,281 lb. of refined copper, 51,608 oz. of silver, and 306,532 oz. of gold. Dividends were paid in March and June aggregating $1,089,322, making total dividends to date of $2,720,826. The mill treated 2,427,700 tons of ore averaging 35.2 lb. of copper per ton, and 2591 tons of ore averaging 237.34 lb. per ton was shipped to smelters. The average net yield in refined copper per ton of ore treated was about 23.5 lb. The accompanying table gives a summary of the total production:

TOTAL PRODUCTION OF RAY CONSOLIDATED

Year.	Tons of Ore.	Lb. Cu per Ton.	Total Lb. Refined Copper Prod.	Value of Other Metals.
1911	618,519	21.9	14,935,047	$926
1912	1,565,875	22.2	34,674,275	8,269
1913	2,365,296	22.2	52,341,029	51,396
1914	2,430,291	23.5	57,004,281	34,761
Total	7,042,981	22.6	158,954,632	$95,352

During the first 7 months of 1914 the plants were running at about full capacity, but with the beginning of the war, production was cut to 50 per cent. of normal capacity.

The total development during the year was 75,261 ft., which is 9468 ft. less than in 1913. Development since the commencement of mining operations to the end of 1914 amounts to 452,233 ft., or about 85 miles. Of this, about 34 miles has been destroyed by mining operations. It is

stated that the mine is now thoroughly opened, so that all production requirements may be easily met.

The ore reserves have been re-calculated and were estimated on Dec. 31, 1914, to contain 74,765,789 tons averaging 2.214 per cent. copper. This ore underlies an area of 205.2 acres. This re-calculated tonnage is about 1.5 per cent. less than the former estimate; but to offset this, the copper contents indicated by the new data obtained raise the average grade about 1 per cent. This new estimate was made after exploring the margin of the main ore-body.

During the second quarter of the year the average daily output was 8296 tons. A total of 2,429,330 tons was mined, of which 2591 tons was shipped to the smelter; the remainder was concentrating ore and averaged 1.7604 per cent. copper.

It is estimated that there is a reserve of 5,000,000 tons of broken ore in the stopes. Mining cost was 62.42 cts. per ton, compared with 73.23 cts. in 1913. This cost includes general fixed charges and the cost of coarse crushing and loading the ore into cars. The cost of crushing and loading into cars was 3.1 cts. per ton, making the mining cost proper 59.32 cts. per ton. Eliminating No. 3 shaft, where the cost of mining is higher on account of square setting, the cost was 54.21 cts. per ton.

If the milling plant had operated during the last of the year at the same rate as during the first half, the year's tonnage would have been 3,006,129 tons. Mill ore averaged 1.76 per cent. copper, and the average rate of extraction was 67.88 per cent. The cost of milling was 49.88 cts. per ton, compared with 51.93 cts. for 1913. The average grade of concentrates was 19.25 per cent., compared with 18.55 in 1913.

The average cost per lb. of refined copper was 8.868 cts., after crediting earnings from the railroad. The combined cost of refined copper from milling and shipping ore was 8.839 cts. per lb. These costs include all operating and general charges. By crediting all miscellaneous income to cost, the net cost of copper produced was 8.763 cts. per lb.

No new construction work is contemplated during the coming year, but some changes in the milling practice are being considered which will require incidental changes in the mechanical arrangements.

Phelps, Dodge & Co., with an authorized capital of $50,000,000, $45,000,000 issued, controls the following operating companies: Copper Queen Consolidated Mining Co., Detroit Copper Mining Co. of Arizona, Moctezuma Copper Co., Burro Mountain Copper Co., Stag Cañon Fuel Co., and the Phelps-Dodge Mercantile Co.

The total copper ore extracted from the mines amounted to 1,777,243 tons, of which 1,046,728 tons was submitted to preliminary concentration and 730,515 tons smelted direct. The quantity of copper made during

the year 1914 by the constituent companies controlled by Phelps, Dodge & Co. was 140,231,384 lb., of which 8,569,060 lb. was made from the Miami Co.'s ores and the resulting product in blister copper was delivered to them. Including copper received from outside sources, 188,687,378 lb. was sold and delivered to buyers at an average price of 13.57 cts. per lb., net cash f.o.b. New York.

The president, James Douglas, states that the current of the copper trade has been deflected from its normal channels, like other markets of the world, by the war which started on August 1. From January to August the demand for copper was more sluggish than it had been in 1913. During the period from August to December both the domestic and foreign demand fell off to such a degree that it became imperative to reduce production. The output of the Douglas and Detroit smelters was contracted 40.48 per cent. As a result, copper shipments from the smelting works of the company during this period were only 59.34 per cent. of normal. The revolutionary movements in Mexico have slightly embarrassed operations there and correspondingly reduced the output.

At both the Copper Queen mine and at the mines of the Moctezuma Copper Co. the visible reserves have been notably increased, and improved methods in both mining and smelting have reduced the cost of production. The tendency of legislation in the new state of Arizona has been somewhat radical, but the people as well as their representatives recognize the dependence of the state on the prosperity of mining and may be counted upon to encourage rather than depress that industry, even though some drastic experiments may be tried before an equitable system of state regulation and taxation will be reached.

The company's revenue from subsidiaries was $6,350,000, and commissions, etc., $541,651, a total of $6,891,651, of which $6,300,000 was paid in dividends. The surplus is $7,011,109. During the year the Tombstone Consolidated property was acquired, and will be operated under the name of the Bunker Hill Mines Co.

The Limestone mine reserves have increased from 211,199 to 257,077 tons of lean sulphide, and 2,357,729 to 2,834,862 tons of mine run ore. Most of the porphyry ores of Sacramento Hill must be submitted to preliminary concentration. Methods of mining in 1914 showed the following: square set, 76.1 per cent.; top slice, 13.9 per cent.; cut and fill, 8.2 per cent.; and shrinkage, 1.8 per cent., in 694,942 tons extracted. Stoping costs were reduced.

The smelter treated 654,669 tons of Copper Queen ore and other material, averaging 6.25 per cent. copper, 0.02 oz. gold, and 1.01 oz. silver, yielding 76,842,973 lb. copper, 14,987 oz. gold, and 627,612 oz. silver. The total material treated in the plant amounted to 1,012,177

tons, yielding 119,957,017 lb. copper, 1,405,301 oz. silver, and 26,259 oz. gold. This included concentrate from the Moctezuma in Sonora, and custom ore. There were 946 men employed in the departments.

Ore shipped to El Paso amounted to 23,930 tons, containing 8,889,175 lb. lead, 399,106 lb. copper, 332,106 oz. silver, and 1822 oz. gold. The experimental plant also treated 3150 tons for 130,342 lb. copper.

The Copper Queen metal output was 86,066,143 lb. copper, 8,889,175 lb. lead, 1,036,672 oz. silver, and 15,769 oz. gold, from 732,829 tons of ore, precipitate, and slag. Net earnings totaled $6,042,001, and $4,500,000 was paid in dividends.

Detroit Copper Mining Co. of Arizona.—The reports of the general manager, A. T. Thomson; mine superintendent, M. H. McLean; and smelter superintendent, V. P. Hastings, contain the following data:

Development amounted to 12,766 ft. in the five principal mines and 13,609 ft. in outside properties, a total of 26,375 ft. Ore production was 217,876 tons from the Ryerson mine, 85,119 from the Yankie, 128,641 from the Copper Mountain, 39,310 from the Arizona Central, 1202 from the Colorado, and 46 from the Antietam, a total of 472,194 tons. This averaged 2.899 per cent. Out of this tonnage, 459,473 tons was concentrating ore. Lessees mined 773 tons containing from 4.71 to 21.19 per cent. copper from 13 mines, and 61.7 tons of precipitate averaged 52.13 per cent. Exploration on the outside property was not encouraging and ore reserves decreased, in spite of good results in the Ryerson and Yankie.

The blast furnace smelted a total of 129,530 tons of mixed charge, and the output of copper was 20,274,367 lb. Net earnings for the year were $602,319, and $280,000 was paid in dividends. There were 1438 men employed.

Moctezuma Copper Co.—This company, in charge of J. S. Williams, Jr., operates at Nacozari, Sonora, Mexico, and has been the scene of revolutionary movements for some time past, and the general manager states that nothing but the political unrest in the country would prevent the property being a more active producer than it has been. (See section on *Mexico*.)

Operations of the United Verde Copper Co. in 1914, compared with the 3 years previous, were as follows:[1]

	1911.	1912.	1913.	1914.
Copper	$4,174,478	$5,279,442	$5,357,840	$4,397,905
Silver	246,685	298,155	381,350	350,447
Gold	315,691	321,860	431,926	438,557
Total	$4,736,834	$5,899,860	$6,171,116	$5,186,909

[1] *Min. Eng. World*, Feb. 27, 1915.

Production of metals compares as follows:

	Copper, Lb.	Silver, Oz.	Gold, Oz.
1908	36,183,089	494,574	20,334
1909	36,694,063	495,480	17,022
1910	38,663,880	563,133	19,267
1911	33,167,987	461,145	15,239
1912	31,565,987	484,222	15,082
1913	35,333,924	641,626	20,664
1914	32,449,116	646,285	21,393

Average prices received for copper, gold, and silver have been as follows:

	Copper, Cents Lb.	Silver, Cents Oz.	Gold, per Oz.
1911	12.586	53.49	$20.72
1912	16.725	61.57	21.34
1913	15.164	59.434	20.902
1914	13.553	54.225	20.50

The new smelter has not yet been completed, but construction could be rushed so that production could start within 60 days. Two furnaces of the old smelter are turning out present production, but the old plant will be abandoned when the new smelter blows in. The new plant will have a normal capacity of 5,000,000 lb. per month.

The Miami Copper Co., Miami, Ariz., for 1914 reports that 1,099,208 tons of ore was hoisted and 1,096,633 tons milled, averaging 2.28 per cent. copper. From this ore 44,579 tons of concentrates was produced, averaging 39.31 per cent. copper. The total copper in concentrates amounted to 35,048,445 lb., of which 33,296,010 lb. was recovered as refined copper. Copper sales for 1914 aggregated 32,879,447 lb. at 14.3488 cts. per lb.

Underground development consisted of 22,865 ft. within the Captain ore-body. On account of the thickness of the ore it is planned to extract it in two lifts, the upper one consisting of ore above the 270-ft. level, from which point a transfer will be made to the main tramming level through specially prepared raises. Blasting of the pillars between the shrinkage stope rooms in the Northwest ore-body was completed in the early part of the year, and the drawing of broken ore started. About 60 per cent. of the total ore hoisted came from this area.

The mill was operated at full capacity during the first 7 months of the year, but production was reduced in the latter part of the year on account of the war. Improvements made proved a success, and plans were made for remodeling the entire plant to treat 4200 tons a day. The change consists principally in finer grinding and additional table treatment on the sand floor of the mill and improved methods of handling and treating the slime products. The increased capacity on the sand floor will be obtained by using double-deck tables, and finer grinding will be accomplished by 8-ft. by 66-in. Hardinge conical pebble mills in the sand-floor tunnels. The product of these mills will be raised by elevators and re-clas-

sified for table treatment. The material leaving the sand floor will have the fine sands removed in 8-ft. conical tanks, the overflow of which will pass to six Dorr thickeners 46 ft. in diam. by 10 ft. deep, one to each section, and located outside of the mill building. The thickened pulp will join the reject from the slime tables for further treatment. The mill bins will be raised to 10,000 tons capacity.

Further prospecting was stopped at the time of the curtailment in production, so no increase in ore reserves is shown except what was opened by current development. Ore reserves are estimated to contain 19,500,000 tons of sulphide ore averaging 2.4 per cent.; 17,000,000 tons averaging 1.21 per cent. copper, and 6,000,000 tons of mixed sulphide and oxidized ore averaging about 2 per cent. copper. Experiments are under way to determine some way to treat this mixed ore, and it is hoped that within a reasonable time this ore will be available for treatment. According to these figures, there are about 13 years of operations on the high-grade ore alone and about 25 years of life on an average grade of 1.85 per cent. ore, if the 17,000,000 tons of 1.21 per cent. ore is considered.

The United Globe Mines, Globe, Ariz., reports a production during 1914 of 11,086,674 lb. of refined copper, 91,582 oz. of silver, and 1579 oz. of gold from 155,205 tons of ore. The average grade of all ore was 3.57 per cent. copper. The receipts from the sale of this ore amounted to $1,095,560. Expenses were $663,022, leaving a net profit of $432,538 for the year. This profit is before deducting depreciation. Dividends totaling $425,500 were paid, making dividends to date $1,955,000. The principal product of the United Globe is concentrating ore.

The Shattuck-Arizona Copper Co., operating mines in Cochise County, smelted 84,801 dry tons of copper ore during 1914. The copper recovery amounted to 10,846,918 lb., and was produced at a net cost of 8.72 cts. per lb. In addition to the copper there was produced 14,065 lb. lead, 198,419 oz. silver, and 2445 oz. gold. The total revenue to the company was $1,660,573, of which $587,497 was net profit. The company paid dividends to the extent of $525,000, leaving on hand cash and metal to the value of $1,045,315. During August, September, and October the output was curtailed to 50 per cent. of the normal, and finally the mine was closed, as a result of the depression in the copper industry. Development work is reported to show encouraging results on the 200-, 400-, 700-, and 850-ft. levels in the copper area, and the mine is said to be in good condition.

The Old Dominion Copper Mining & Smelting Co., Globe, Ariz., reports a production of 30,210,361 lb. of copper, 148,459 oz. of silver and 3308 oz. of gold from ores smelted in 1914. Of this production, 17,816,284 lb. of copper, 33,311 oz. of silver and 602 oz. of gold came from Old

Dominion ores and the remainder from custom ores. The total amount received for the metals from company ore was $2,473,582; the profits from the treatment of custom ores, $200,623, and the total receipts, $2,674,205. Expenses at Globe were $1,431,654, and refining, commissions, transportation, taxes and other expenses were $264,042, making the total expenses $1,695,696. The net earnings for the year were $978,509. Depreciation on plant amounting to $570,750 is not included in the figures just given. Dividend payments were $445,500, making total dividends to date $3,807,000. The mines produced 129,813 tons of ore, averaging 7.44 per cent. copper, and the mining cost was $5.20, compared with a cost of $4.78 in 1913. Development work totaled 15,665 ft. The average flow of water in the mine was 3,350,000 gal. per 24 hr. Power costs for 1914 were $68.81 per hp.-year, compared with $71.02 per hp.-year in 1913. The concentrating plant treated 151,893 dry tons of ore averaging 4.67 per cent. copper at a cost of 93.2c., compared with a cost of 87.8c. in 1913. Deducting oil-flotation experimental expense in 1914, however, the cost of concentration was about the same as during the previous year.

California.—During 1914 the production of copper in California amounted to 29,515,488 lb., which is less than that state has produced for several years. The decrease is chargeable to the effects of the European war. The copper mining and smelting situation in Shasta County in the first quarter of the year showed a decided improvement over 1913 conditions, but as the price of copper fell and the bottom dropped out of the market, operations were greatly hampered.

During the first part of the year the Mammoth Copper Co., of Kenneth, acquired by purchase two large groups of copper claims, the Spread Eagle and Stowell groups, and took purchase options on others, the total area amounting to 1500 acres. During the late summer and fall the Mammoth's production fell off about one-third by the shutting down of one of the three furnaces at the smelter. The farmers of Shasta County have renewed their efforts of last year to close the Mammoth smelter, a suit having been filed in the U. S. District Court in November, but no action was taken by the court up to the close of the year. The opposition on the part of the farmers has kept all the development companies practically at a standstill, except the Mammoth, as they did not feel justified in expanding their operations until some definite decision had been reached insuring freedom to continue smelting works without fear of being enjoined. The recent expansion of the Mammoth is taken as a good sign that the trouble is practically at an end, and it is said that some of the farmers have admitted that no recent damage has been done to the trees and crops.

A large amount of development has been done on the properties taken over by the Mammoth and some ore has been found. The Spread Eagle and the Stowell have been diamond drilled and also developed by tunnels. Diamond drilling has also been done on the Keystone and the Shasta Copper Exploration Co. properties. The Stowell has a 1200-ft. tunnel; the other tunnels are shorter. The Mammoth Co. will build a wagon road to the Spread Eagle and will probably install a compressor during this year. All of these properties purchased and under option to the Mammoth are situated between the Balaklala and the Iron Mountain mines. One group of Trinity Copper Co. properties lies between the Spread Eagle and Iron Mountain; the other lies north of the Balaklala. The Golinsky lies east of the Mammoth's Backbone group. Both the Trinity Copper Co. lower group of mines and the Golinsky mines have been developed to a point where production waits only an active mining and reduction of the ores. During the past 3 years the Shasta Copper Exploration Co. has done a large amount of exploration and development on the West Side, and has kept the section alive by persistent exploiting against the strong odds that the farmers might succeed in killing the copper-mining industry in Shasta County.

Idaho.—The annual report of the State Inspector of Mines, Mr. R. N. Bell, for the year 1914 shows the copper production of Idaho for the last 5 years to be as follows:

	Pounds.
1910	5,837,639
1911	3,962,060
1912	7,392,280
1913	8,627,242
1914	5,178,000

The principal producing mines are in Shoshone and Custer Counties, and with the rich ore-body of the Snowstorm mine, which was the only important copper producer in Shoshone County, now completely mined out, the copper output of the state will come chiefly from Custer County.

In the Snowstorm mine above Mullan, the stoping ore became exhausted in September and mill operations were suspended. The fault which cut out the ore on the No. 3 tunnel level, it is said, has been partly overcome by the discovery of the vein below the fault, and present indications are favorable to the recovery of the original ore-body in this deep development.

The National mine, between the Snowstorm and the town of Mullan, completed a magnificent modern concentrating mill of 500 tons daily capacity, and was in shape to operate its magnificent resources of copper concentrating ore when war was declared in August and cut off the market for its product, since which time the enterprise has been shut down and remained idle.

Custer County Mines.—At Mackay the Empire Copper Co.'s market for ore was shut off during the summer by the war, but a full complement of lease operations has since been continued by the company, giving employment to a force of over 60 men, and when visited last fall the many interesting phases of this company's group of mineral claims was showing the usual rich promise of continued production when a market is afforded. This company is pushing a deep tunnel that will undercut the main deposits nearly 1000 ft. below the present lowest level. This tunnel has already attained a length of between 3000 and 4000 ft. and will probably be driven into the main ore zone within another year, and has every promise of disclosing a greatly expanded tonnage of profitable copper ore. This company is also planning the erection of a Christensen process mill with which to treat its extensive body of low-grade mineral on the ground that will not stand present shipping charges.

Michigan.[1]—The year 1914 was a most trying one for the Lake Superior copper district. The companies and employees were just getting nicely squared away from the effects of the strike of the Western Federation of Miners when the European war broke out, demoralizing the copper market and forcing a general curtailment of the working forces and a lowering of wages.

The strike was officially called off in April. Although the mines had been working at full force for some months previous to this, it had cost a lot of money, and during the early part of the year production was practically suspended, so that at the outbreak of the war the companies were not in good financial condition to withstand this serious handicap. A general reduction of 10 per cent. was made in wages, and the Calumet & Hecla Mining Co. and subsidiaries went on three-quarter time Sept. 1, and the Copper Range mines on half time, working 2 weeks and shutting down completely for the remaining 2 weeks in each month. A number of the smaller companies suspended operations completely, and as a result there were a number of unemployed men throughout the district. Production was reduced in about direct proportion, with the exception of a possible slight increase in the efficiency of the working force and a little larger production per man employed.

The production of copper in Michigan during 1914 was 158,009,748 lb., as compared with 155,715,286 lb. in 1913.[2] In the following tables the production of the principal companies and the dividends for the last few years are given.

[1] Mining notes by C. L. C. Fichtel, *Eng. Min. Jour.*, Jan. 9, 1915.
[2] Advance statement, U. S. Geol. Surv.

COPPER PRODUCTION IN MICHIGAN
(Pounds of fine copper)

Mines.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.
Adventure...	1,552,628	1,244,872	90,870	*Nil*	*Nil*	*Nil*	8,727,312	.....	.....
Ahmeek.....	3,077,507	5,527,672	6,280,241	9,198,110	11,844,954	15,196,127	16,455,769	9,220,874	13,643,605
Allouez.....	3,486,900	2,934,116	3,047,051	4,031,532	4,655,702	4,780,494	5,525,455	4,091,129	6,056,548
Atlantic.....	1,439,082	*Nil*	*Nil*	43,483	19,018	*Nil*	*Nil*	44,370	.....
Baltic.....	14,397,557	16,704,868	17,724,854	17,817,836	17,549,762	15,370,449	13,373,961	7,736,124	7,001,945
Cal. & Hecla.	94,529,821	88,055,723	81,660,723	74,593,553	72,672,469	72,861,925	67,856,429	45,016,890	53,691,562
Centennial...	2,253,015	2,373,572	2,196,377	2,583,793	1,572,566	1,493,834	1,742,338	1,612,262	2,287,532
Champion...	16,954,986	16,489,436	17,786,763	18,005,071	19,224,124	15,639,426	17,225,508	12,080,592	15,807,206
Franklin	4,571,570	4,401,248	3,703,421	1,615,556	966,353	820,203	1,710,651	1,021,440	.....
Isle Royale..	2,937,098	2,667,608	3,011,664	5,719,056	7,567,399	7,490,120	8,186,957	4,158,584	6,593,451
Mass.....	2,106,739	2,078,677	1,766,930	1,723,436	1,321,885	1,326,898	2,045,006	1,213,545	2,944,952
Michigan....	2,875,341	2,665,404	3,000,206	1,979,305	36,682	327,773	300,000	.....	.....
Mohawk.....	9,352,252	10,107,266	10,295,881	11,248,474	11,412,066	12,091,056	11,995,598	5,778,235	.....
Osceola.....	18,588,451	14,134,753	21,250,794	25,296,657	19,346,566	18,388,193	18,413,387	11,325,010	14,970,737
La Salle.....	.....	.....	.....	.....	.....	.....	.....	287,200	.....
Quincy.....	16,194,940	19,796,058	20,600,361	22,511,984	22,517,014	22,252,943	20,634,800	12,184,128	.....
Superior.....	.....	.....	21,244	1,789,315	3,181,041	3,236,233	3,921,974	2,992,765	3,217,635
Tamarack...	9,832,644	11,078,604	12,806,127	13,533,207	11,063,606	7,494,077	7,908,746	4,168,743	1,074,808
Trimountain	9,507,933	8,190,711	6,034,908	5,282,404	5,694,868	6,120,417	6,980,713	4,990,938	5,048,306
Winona.....	278,182	1,285,863	*Nil*	*Nil*	*Nil*	*Nil*	2,307,237	1,448,737	1,352,084
Wolverine...	9,548,123	9,273,351	9,555,233	9,971,482	10,469,253	9,630,639	9,408,960	1,550,000	.....
Victoria.....	.....	1,207,237	1,290,040	1,164,564	1,164,564	1,303,331	1,224,911	4,488,000	.....
Others.....	.....	100,000	.....	2,862,233	899,647	294,873		.....	.....
Totals	224,071,103	220,317,041	222,123,688	230,971,051	223,179,539	216,119,011	225,945,712	.....	.....

DIVIDENDS PAID BY MICHIGAN MINES

Mine.	1912.	1913.	1914.	Mine.	1912.	1913.	1914.
Calumet & Hecla	$4,200,000	$3,200,000	$1,000,000	Quincy ...	$550,000	$412,500	$55,000
Copper Range Con.....	2,100,000	1,082,700	.....	Tamarack.	.....	.....	.....
Mohawk.....	350,000	500,000	100,000	Wolverine	550,000	300,000	240,000
Osceola.....	1,153,800	1,009,580	288,450	Totals....	$8,903,800	$6,504,780	$1,683,450

The Keweenaw Copper Co. carried on development work at the Phoenix property on the Ashbed lode; the shaft was put down several hundred feet and drifts extended from the various levels. The formation is flat and comparatively wide, and the copper contents most encouraging. The Wolverine and Mohawk properties were operated full time during the latter part of the year when the other mines were working at reduced time. This was consistent, because the output of these mines is taken for trade in the United States.

The Tamarack Mining Co. completely suspended operations at the mine, with the exception of pumping. Plans were laid for working over of the tailing piles and a large structural-steel building is about completed, which will be used for a regrinding and concentrating plant. This plant when completed will contain 32 Hardinge mills.

The Calumet & Hecla Mining Co. put into commission its electrolytic plant at Hubbell and discontinued the Black Rock smelting works at Buffalo, and is treating all the electrolytic copper for its mines and subsidiaries at this plant.

The first portion of the No. 2 re-grinding plant, consisting of 16 Hardinge mills together with their complement of tables, went into commission during the summer. The 20-in. hydraulic dredge that will be used in the reclamation of the tailing piles was completed and given a trial run, and worked well. All construction work was stopped at the outbreak of the war and nothing further was done toward the completion of this plant. The company laid plans for a leaching plant and the excavations were started, but this also was stopped and the contract for the structural steel was canceled. A central employment bureau was established through which all the men for the Calumet & Hecla plants and all subsidiary companies will be handled.

The Osceola Consolidated Mining Co., Houghton, Mich., reports a production of 14,970,737 lb. of copper for 1914, which was sold for an average of 13.14 cts. per lb., making total receipts $1,967,725. Expenses were $1,615,139 and consisted of $1,425,205 for mining, milling and transportation, $21,109 for construction, $167,734 for smelting, freight, commissions, etc., and $1091 for interest. The net profit for the year was $352,786 and dividend payments totaled $288,450, leaving $64,136 to be added to surplus. Total dividends to date amount to $12,179,675.

There was 1,136,118 tons of rock hoisted, of which 2.436 per cent., or 27,671 tons, was discarded as waste. The mill treated 1,108,447 tons, yielding 20,997,900 lb. of mineral which yielded 71.296 per cent. refined copper. This is equal to a yield of 13.5 lb. of refined copper per ton of rock treated.

The Osceola company started work on the foot-wall formation at the main mine and had a new shaft house nearly completed at the No. 3 shaft, which has been idle for a number of years, when the curtailment went into effect. Nothing was done at the Laurium property during the year and the La Salle company suspended operations, as did also the Hancock, with the exception of pumping.

The Superior Copper Co. lost the boiler and compressor house at its No. 1 shaft through fire, which necessitated the shutting down of the mine for about 3 weeks.

The Copper Range Consolidated Mining Co. carried on normal operations until about Sept. 1, when it went on half time. During the year, one of the largest masses of copper discovered in the district has been uncovered in the Trimountain mine; it was first encountered between the 24th and 25th levels and has been uncovered down to the 27th level and extends along the lateral for about 40 ft. with an average thickness of about 8 in.

The annual report shows an income for the year 1914 of $494,600, as compared with $490,536 for 1913. The production from which earnings

were derived was 19,953,854 lb. of copper, obtained from the Baltic, Trimountain, and one-half of Champion. The average cost was 10.661 cts. per lb., compared with 11.71 cts. for the previous year. The average yield of copper per ton of rock for all of the mines was 21.95 lb., compared with 25.24 lb. in 1913.

The report of the Mohawk Mining Co., Mohawk, Mich., for 1913, shows a production of 5,778,235 lb. of copper, which was sold at an average price of 15.36 cts. per lb. The production in 1912, before the strike, was 11,995,598 lb. The profits for 1913 were $123,839, compared with $656,435 for 1912. After paying dividends amounting to $500,000, a surplus of $521,155 was on hand at the end of the year. There was 395,100 tons of rock hoisted, of which 7.2 per cent. was discarded as waste, leaving 366,458 tons treated, which produced 8,018,000 lb. of mineral or 5,778,235 lb. of refined copper. This gives a yield of 15.67 lb. of copper per ton of rock stamped. The total cost of producing copper was 13.22 cts., made up as follows: mining and milling, including transportation, 10.42 cts.; smelting, freight, and marketing product, $1.16 cts.; construction and strike expense, 1.64 cts. per lb.

The Winona Copper Co., Houghton, Mich., showed net assets over liabilities on Jan. 1, 1915, of $92,649, of which $37,462 consisted of unpaid assessments. Rock stamped in 1914 amounted to 123,339 tons, from which 2,239,170 lb. of mineral was produced. This, when refined, yielded 1,352,084 lb. of copper. This is equivalent to 18.15 lb. of mineral and 10.96 lb. of copper per ton of rock stamped. There were 771,442 lb. of copper sold at 14.2 cts. per lb., and 580,643 lb. remained unsold. The mine was shut down in August, after reaching the greatest monthly output in its existence in July, and remained closed until October, when 35 of the best workmen resumed work on a tributing arrangement, by which the company receives 50 per cent. of the returns over the wages.

The Allouez Mining Co., Calumet, Mich., for 1914 reports a profit of $114,530 from a production of 6,056,548 lb. of refined copper sold at 12.853 cts. per lb. Silver sales amounted to $13,402, making total receipts $791,821. Expenses for operations were $672,114, and interest payments, $5176. From 354,457 tons of ore stamped 9,408,470 lb. of mineral was obtained, which contained 64.37 per cent. of refined copper. The yield per ton of rock stamped was 17.09 lb. of copper. The cost of producing copper during the year was 11.18 cts. per lb.

The White Pine Copper Co. in Ontonagon County, which is under the control of the Calumet & Hecla Mining Co., carried on operations throughout 1914 in a consistent manner. Two shafts were opened and the formation developed was rich. A 1000-ton mill is in course of erection and will go into commission in 1915.

Missouri.—During 1914 Missouri produced 53,519 lb. of copper derived mainly from the dressing of lead concentrates from mines in the southeastern part of the state. The only mine reporting production of copper ore was the Swansea mine, in St. Genevieve County, which produced oxidized ore carrying copper and silver.

Montana.—Montana ranks second among the states in magnitude of production for 1914, the output for the year being 236,805,845 lb.,[1] as compared with 285,718,918 lb. in 1913. Most of Montana's production comes from the Butte district, which produced about 283,600,000 lb. in 1913, and 223,720,000 lb. in 1914. The largest single producer is the Anaconda Copper Co. whose output for last year was 205,298,531 lb., and for 1913 was 270,301,644 lb.

According to the annual report of the Anaconda Copper Co., the mines of the company did 33.15 miles of development work and, in spite of the interruption caused by labor troubles, the ore reserves were increased by a tonnage slightly in excess of the ore extracted during the year. The mines produced during 1914—3,898,100 tons of ore, and 6782 tons of precipitates, making a total of 3,904,882 tons.

The reduction works treated a total of 3,748,726 tons of ore and other cupriferous material at Anaconda, and 488,243 tons at Great Falls. The results of these operations were as follows:

	Lb., Copper.	Oz., Silver.	Oz., Gold.
Smelter	188,664,551	7,555,915	78,815
Anaconda	35,055,741	758,200	20,835
Great Falls			
Total	223,720,292	8,314,115	99,650

At the Washoe smeltery the round-table plant was completed early in the year, and was successfully operated during the entire remainder of the year. The results exceeded all expectations, not only as to per cent. of recovery, but also as to the copper contents of the concentrates. Work upon the 2000-ton leaching plant was carried on without cessation, and it is expected to be completed by May, 1915, and will treat the sand tailings which have accumulated from the operations of former years, amounting to many millions of tons. This plant when operating will produce about 700,000 lb. of copper per month at a very low cost. The 100-ton acid plant will be completed by May, 1915, and its entire output will be used in the leaching plant. One reverberatory furnace was equipped with coal-dust-firing apparatus, and tests were made with different grades of coal, with such good results that the entire plant will be remodeled and operated with pulverized coal. The benefits which it is expected will result from this kind of practice will very materially affect the cost of production, as a much heavier charge per furnace will

[1] Advance statement, U. S. Geol. Surv.

be treated, with a much lower coal ratio than before. The blast-furnace department will be maintained in its present good condition for use in case of emergency or for increasing the production. A new roaster plant consisting of 40 furnaces will also be installed. The converter department is to be equipped with the Great Falls type of cylindrical converters, 20 ft. in diameter, and a reverberatory furnace is to be built for use in cleaning the slag from the converters.

At the Great Falls smeltery it is planned to abandon the blast-furnace practice, and to treat in coal-dust-fired reverberatories the concentrates shipped from Anaconda. The new reverberatory furnaces will be built during the year 1915. The present antiquated electrolytic refinery is to be replaced with a modern plant having a capacity of 10,000,000 lb. per month. These improvements, it is estimated, will cost in the neighborhood of $2,000,000.

The shafts of the different properties were sunk during the year to additional depth aggregating 3460 ft., and extensive repairs were made in the shafts of the Mountain Consolidated, Diamond, Steward, and Montain View properties. The Never Sweat mine was not operated during the year, and all work on the Nettie and Tropic mines was discontinued early in August. Development work was especially satisfactory in the Leonard, West Colusa, Steward, Original, Tramway, Anaconda, Badger State, and West Gray Rock mines.

During the year the North Butte Mining Co. shipped 343,314 wet tons of ore, and 71 wet tons of precipitates, to the Anaconda smelter. This ore produced 18,421,761 lb. of copper, 1,092,300 oz. silver, and 1107 oz. of gold. The total earnings of the company were $3,084,774, and the net income was $358,215. In order to block out the company's mining properties, there were purchased during the year additional interests in the Lillie May and Sunset lode mining claims, and the entire interest in the King fraction claim, and a small silver fractional claim, adjoining the company's original mining properties in the West Side mineral district. In the Butte East Side mineral areas additional interests were purchased. Looking toward the erection of a plant in which to treat the ores of the company, suitable ground with ample water right has been purchased.

In 1914 the East-Butte Copper Co. worked only 220 days, being idle from August 8 to the end of the year. While in operation the yield was greater than in the previous year. Development in the Pittsmont mine totaled 4814 ft. The main shaft was sunk from 1585 to 1770 ft. In the upper levels a large tonnage of new ore was opened up. The company treated 110,992 tons of ore, from which 9,175,579 lb. of copper, 242,437 oz. silver, and 2219 oz. of gold were extracted.

The report of the Tuolumne Copper Mining Co. states that the ore

mined during 1914 averaged 4.1 per cent. copper, and produced 1,945,286 lb. of copper, 115,355 oz. silver, and 150 oz. of gold. The net return on these metals amounted to $133,515. Work was stopped on Oct. 24, on account of the market conditions.

Nevada.—As a result of the curtailment of output made necessary by the war the production of copper in Nevada during 1914 decreased from 85,209,536 lb. in 1913 to 60,122,904 lb.[1] The bulk of Nevada's copper output comes from the operations of the Nevada Consolidated Copper Co. at Ely. During the last 5 months of the year that company operated on a 50 per cent. basis, and the decrease in the state's yield in copper is thus largely accounted for. The Nevada Consolidated began producing in 1908, and up to the close of 1914 the total output of blister copper amounted to 166,447 long tons,[2] or 372,842,240 lb.

Copper production of the Nevada Consolidated Copper Co. for 1914, according to the company's annual report, was 49,244,056 lb., which was sold at 13.396 cts. per lb., compared with 69,972,829 lb. at 14.879 cts. the previous year.

Production for the first half of the year, according to President Eccles, was lower than during any previous period since 1909, when the plant was completed for full operations. This was due to the necessity of mining, during the second quarter of the year, a very large tonnage of low-grade ore averaging only 1.1 per cent. copper. This was necessary in order to secure the best conditions in the pits for future operations. Average grade treated during the year was consequently reduced, being 1.483 per cent. copper, *versus* 1.599 per cent. for the preceding year.

Cost of producing after crediting all miscellaneous earnings, but before providing for plant and equipment depreciation, was 8.91 cts. per lb., *versus* 8.68 cts. for the previous year. Including plant and equipment depreciation and charges of every character, except ore extinguishment, this is increased to 9.82 cts. per lb., as compared to 9.51 cts. for the year ended Dec. 31, 1913.

During the year prospecting to develop additional ore was systematically carried on with the result that 4,552,000 tons, averaging 1.87 per cent. copper, was added to available ore reserves. There was milled during 1914, 2,640,294 tons averaging 1.483 per cent. copper, leaving 41,020,296 tons of ore, averaging 1.68 per cent. copper, in reserve Dec. 31, 1914, as compared with 39,108,590 tons, averaging 1.65 per cent. Dec. 31, 1913, an increase of 1,911,706 tons. There still remains in reserve more developed ore than at the end of any previous fiscal year.

From the beginning of operations in July, 1908, to Dec. 31, 1914, a period of 6½ years, 14,917,287 cu. yd. of overburden has been removed

[1] Advance statement, U. S. Geol. Surv.

[2] *Salt Lake Min. Rev.*, Jan. 15, 1915.

in uncovering the ore-body, 15,391,491 tons of ore has been milled, 355,287,601 lb. of refined copper produced, and $14,977,250 has been paid in dividends.

Several months ago the Nevada Consolidated absorbed its subsidiary, the Steptoe Valley Smelting & Mining Co., which owned the reduction works at McGill, and all business is now done in the name of the parent company. Milling operations at McGill now handle an average of 5000 tons of ore a day through the concentrator, where more than 12,000 tons has been milled in 24 hours at times in the past.

For some months past considerable attention has been devoted to experimenting with an oil flotation process and with encouraging results. While the saving of values by the ordinary concentration processes used is generally less than 70 per cent., it is understood that the oil process has been perfected on a small scale, so that a much greater percentage of the values can be saved. Steps are now being taken to experiment with the oil process on a larger scale, while the curtailment in output by the company makes part of the concentrator building available. It is believed that if the oil process can be successfully demonstrated on a large scale, it will be adopted in the near future as the means of obtaining greater profits for the company shareholders.

Next to the Nevada Consolidated in importance in the Ely copper district is the Consolidated Coppermines Co. This is a merger of the Giroux, Butte and Ely, old Coppermines and Chainman Companies, and when all the details of the consolidation are completed, the Coppermines will be the largest company in point of holdings. It will own 2741 acres of mining claims in the Ely district, and 3085 acres of ranch lands, together with valuable water rights.

The chief work of the Consolidated Coppermines Co. management for the past few months has been the development necessary to putting into sight ore reserves, which on April 30 last were reported at 21,624,236 tons of 1.153 per cent. copper. Substantial tonnages have since been added to reserves, although not sufficient to warrant erection of a mill.

It is understood that the mine management has set upon 40,000,000 tons as a minimum tonnage upon which to base mill construction, and indications now point to the putting into sight of that amount before the end of the summer.

According to the annual report of the Mason Valley Mines Co., the total tonnage of ore smelted during 1914 was 142,197 tons, of which 75,038 tons was from the company's property, and 67,159 tons was custom ore. From this ore there was produced and shipped 212 tons of copper matte, and 4542 tons of blister copper, containing 9,127,974 lb. of copper, 11,553 oz. gold, and 221,151 oz. of silver.

The smelter was in continuous operation from Jan. 6 until it was shut down on Oct. 20, on account of insufficient ore supply. The smelter could not be economically operated on the ores of the company alone, and after the ore and by-products had all been put through, the plant was closed. The only addition to the smeltery was the completion of the converter plant, which was started Jan. 3, 1914, and ran until the plant was shut down in October. A large saving in treatment charges and freight was made as a result of the operations of the converter plant, which produced blister copper for direct shipment to the eastern refineries, and permitted the treatment of a larger tonnage of siliceous ores than was possible before its installation.

New Mexico.—The production of copper in New Mexico during 1914 amounted to 64,204,703 lb.,[1] as compared with 50,196,881 lb. in 1913, which is an increase of nearly 28 per cent. As heretofore, the greatest copper output of the state comes from the porphyry ores of the Chino Copper Co. in the Santa Rita district. This company was producing at the end of the second quarter at the rate of 6,000,000 lb. per month from the treatment of about 6460 tons of ore daily. On account of the war the output was reduced almost one-half during the latter part of the year. During the first 7 months of the year all 5 sections of the present milling plant were in operation 95 per cent. of the possible time, averaging 1345 tons per section daily, while during the last 5 months the daily tonnage for each section was 1085. The mill treated during the year 1,907,300 dry tons of ore, averaging 2.1151 per cent. copper. The total production of concentrates was 147,925 tons, containing an average of 18.505 per cent. copper, or 54,748,254 lb.

The production of copper contained in concentrates for the year, together with that contained in crude ore shipped during the year, was as follows:

	Pounds.
Total production from concentrates	54,748,254
Additional production from direct shipping ore	2,093,723
Total production from both sources	56,841,977

The average cost of net copper produced from concentrates, after making deductions for smelter allowances and crediting gold values, was 7.60 cts. per lb., as compared with 8.787 cts. for the previous years.

The total amount of ore and waste moved by steam shovels during 1914 was 4,192,009 cu. yd. of material in place. Of this amount 3,173,-717 yd. was stripping, and the remainder, equivalent to 2,114,910 tons, was ore. Approximately 185,000 tons was added to the stock pile for the principal reason that it was in the form of large boulders, the breaking of which, before the completion of the new crushing plant, to a size that

[1] Advance statement, U. S. Geol. Surv.

could be conveniently received at the mill, involved too much delay and expense. Ore shipments direct to the smelter amounted to 19,405 tons. The remainder of the ore mined, amounting to a little over 1,910,000 tons, was delivered to the mill.

The average cost for steam shoveling and removing all classes of material during the year was 36.52 cts. per cu. yd., being a decrease of 0.35 cts., as compared with the previous year. The cost of handling waste alone is equivalent to 16.12 cts. per ton, while the cost of ore production alone was 22.13 cts. per ton. The cost of handling waste alone was 0.04 cts. per solid yd. higher than for the previous year, while the cost per ton of ore was 1 ct. less than for 1913. The decreased cost of handling ore as compared to that of the previous year, in spite of the fact that the property was running under restricted output for 5 months, is due in great measure to the benefit derived from the primary crushing plant, permitting a greater efficiency at the shovels.

The total tonnage previously estimated was 93,840,812 tons of 1.77 per cent. copper. The increase, due to the additional ore disclosed by the subsequent drilling, was 1,463,840 tons of 1.47 per cent. copper, giving a grand total of 95,304,652 tons of 1.76 per cent. Since the starting of the mill in 1911 and up to Jan. 1, 1915, there has been treated a total of 5,012,800 dry tons of ore. An additional 21,697 tons of ore was shipped direct to the smelter, making a total of 5,012,800 dry tons of ore mined and disposed of to Jan. 1, 1915, and containing an average of 2.09 per cent. copper. Deducting this from the calculated ore reserves as stated, leaves 90,270,150 tons of ore, averaging 1.75 per cent. copper still available in the fully developed ore-bodies.

The next most important copper operation is that of the Burro Mountain Copper Co. at Leopold. Here development was in progress during the year, and flotation experiments were carried out at the experimental mill at Tyrone, with which the mine is connected by a standard-gauge road and transportation tunnel. Construction of the central power plant, and mine development continued throughout 1914. Near Lordsburg, the 85 Mining Co. and the Bonnie shipped, and some oxidized copper ore was sent to El Paso from the Apache district, near Hachita.

In the Mogollon district, more ore was mined in 1914 than in any previous year; about 120,000 tons was treated by the three mills, the Socorro, Ernestine and Deadwood; a few minor shipments of high-grade ore were made direct to smelters from the Pacific and Eberle mines. The Socorro Mining & Milling Co. was especially active in the development of new properties, having purchased 20 of the Johnson claims from the Oaks company and optioned the Pacific and the Deep Down groups. The

Ernestine company operated about as usual and completed an elaborate geological survey. The Alberta Development Co. and the Precious Metals Exploration Co. became producers, and the Oaks company added another mine, the Eberle, to the list. The Lincoln and the Mogollon Gold & Copper Co. were active part of the year.

Tennessee.—The production of copper in Tennessee during 1914 amounted to 18,661,112 lb.,[1] as compared with 19,489,654 lb. the previous year. The entire output of copper comes from the Ducktown district, Polk County, in the southeastern part of the state. There are two operating companies, the Tennessee Copper Co., and the Ducktown Sulphur, Copper, and Iron Co., and the yearly output of the state is divided between the two companies. In 1914 the Tennessee Copper Co. produced 12,871,113 lb. of copper, as compared with 13,493,140 lb. in 1913. That company also produced 210,163 tons of sulphuric acid. Ore reserves are estimated at 4,010,661 tons, exclusive of the Eureka ore-body.

The report of the Tennessee Copper Co., Copperhill, Tenn., for 1914 shows a production of 12,871,113 lb. of refined copper from 485,051 tons of company ore smelted. Net profits for the year, including acid-plant earnings and earnings from all other sources, amounted to $751,893.

This amount was distributed as follows: Dividends, $600,000; reserve for general depreciation, $100,000; reserve for Federal income tax, $1126; and addition to surplus account, $50,767. Dividends to date aggregate $4,465,250. A record of the production from the company's ore for 1901 to 1914 inclusive shows that $4,978,349 tons of ore has been mined, 4,961,673 tons smelted and 155,493,546 lb. of copper produced. Ore reserves are estimated to contain 5,390,661 tons averaging 26.54 lb. of recoverable copper.

The total cost of producing refined copper was 11.40c. per lb., not crediting the sales of sulphuric acid nor the values of copper in flue dust. The acid plant produced 210,163 tons of 60° Baumé acid. The smelting plant treated 724,822 tons of ore and flux with 38,726 tons of coke.

Utah.—The copper production of Utah during 1914 increased from 148,057,450 lb. in 1913 to 160,589,660 lb.,[2] notwithstanding the depression in the copper industry as a result of the war. This increase came chiefly from the porphyry ores. By far the greater part of Utah's output of copper comes from the Bingham district, and the bulk of that from one mine, the Utah Copper Co. Thus, of the output of 1913, 144,920,000 lb. is credited to the Bingham district, and about 120 million lb. to the single largest company operating there. Of the entire output of the state during the past 44 years, about 50 per cent. was produced

[1] Advance statement, U. S. Geol. Surv.

[2] Advance statement, U. S. Geol. Surv.

from the property of this one company in the last 10 years, and about 40 per cent. during the last 5 years.[1]

During the first half of the year, the Bingham mines were producing at a rate considerably above that of the previous year, the output for the first 7 months totaling 5,896,335 tons of ore, as compared with 5,164,603 tons during the corresponding months in 1913. The total tonnage for the year was about 8,078,000, as compared with 9,190,374 tons in 1913.[2]

The report of the Utah Copper Co., Bingham, Utah, for 1914 shows a production of 115,690,445 lb. of copper, 34,729 oz. of gold, and 325,351 oz. of silver. The net yield of the ore milled was about 17.8 lb. of refined copper per ton. The total value of gold and silver contents was $875,303. Dividends amounting to $4,827,885 were paid during the year, which brings the total dividend payments of the company up to $25,817,815. The report shows a net profit of $6,789,532 from the year's operations and income from investments; but of this amount only $5,379,637 was actually available for dividends, as will be seen by the analysis of the financial statements which follow. The yield of the ore in 1914 was higher than for the previous year, as is shown by the accompanying statement of production for the last 5 years:

UTAH COPPER CO. PRODUCTION FOR LAST FIVE YEARS

Year.	Tons of Ore Treated.	Yield, Lb. Cu per Ton.	Total Copper Produced, Lb.	Total Value of Gold and Silver Produced.
1910	4,340,245	19.46	84,502,475	$1,001,089
1911	4,680,801	19.95	93,514,419	999,622
1912	5,315,321	17.2	91,366,337	873,995
1913	7,519,392	15.2	113,942,834	732,583
1914	6,470,166	17.8	115,690,445	875,303

The total outstanding stock of the company now amounts to 1,624,490 shares. There was an increase of 40,810 shares, which were exchanged for the bonds of the Bingham & Garfield Railroad. A stock dividend was received from the railroad amounting to 15,055 shares; so that now the Utah Copper Co. owns the entire capital stock of the railroad company.

From data obtained in 1914 it was estimated that the capping over the ore-body averaged 115 ft. in thickness. A total of 5,708,836 cu. yd. of stripping was removed during the year, making a total of 27,834,043 cu. yd. of capping removed to date. Stripping operations were extended to an additional 20.5 acres during the year, making a total of 191.63 acres over which stripping operations have been carried on. The total area completely stripped at the end of the year was 76.33 acres. With an average thickness of 115 ft. there are 185,533 cu. yd. of stripping per acre; therefore the stripping to date is equivalent to completely stripping 150

[1] D. C. Jackling, Review of the Mining Industry of Utah, *Salt Lake Min. Rev.*, Sept., 1914.
[2] *Salt Lake Min. Rev.*, Jan. 15, 1915.

acres. It is estimated that the area over which stripping has been completed, or partly completed, contains an average of about 1,558,000 tons of ore per acre, and that the capping removed is equivalent to the complete stripping of 233,700,000 tons of ore. Of this quantity 35,190,400 tons, or about 15 per cent., has been mined. The ratio of stripping to ore is about 1: 4, or about 1 cu. yd. to 8 tons of ore. Of the ore produced 98.27 per cent. was mined by steam shovels. The average cost of steam-shovel mining was 30.96 cts. per ton, of which 8.34 cts. represented charges for stripping and development. The combined cost of surface and underground mining was 32.32 cts. per ton, of which 9.2 cts. was for prospecting with churn drills and for development, 7.5 cts. for stripping expense, and a working cost of 23.12 cts. per ton.

During the year, the mills treated 6,470,166 tons of ore, of which 4,461,461 tons was treated at the Magna plant and 2,008,705 tons at the Arthur plant. The average grade of the ore milled was slightly under 1.425 per cent. copper. The average mill recovery at both plants was 66.04 per cent., as compared with 63.95 per cent. in 1913. The milling cost at the Magna plant was 34.35 cts. and at the Arthur plant 37.55 cts. per ton. The average cost at both plants was 35.36 cts. per ton. The average grade of concentrates was 18.19 per cent. The average cost of copper as reported after deducting gold and silver credits, but not miscellaneous income, was 8.131 cts. per lb. The average total cost of mining and milling, exclusive of transportation charges, was 67.68 cts. per ton.

In 1914 there was 8920 ft. of drill holes completed, which makes the total amount of all drill holes to date 46,391 ft., or an average of 552 ft. per hole for 67 churn-drill holes and seven diamond-drill holes. Ore reserves are estimated to contain 342,500,000 tons of ore, averaging 1.45 per cent. copper. In determining the grade of the ore there were used 56,714 assays, representing 334,518 ft. of development work.[1]

The Bingham Mines Co., Salt Lake City, Utah, reports earnings of $172,530 for 1914. Of this $60,280 came from the earnings of the Dalton & Lark and Commercial mines of Bingham, Utah, and $104,250 from dividends received from the stock of the Eagle & Blue Bell, of Tintic, Utah, owned by the company. The operating statement of the Dalton & Lark and Commercial mines shows a production of 49,780 dry tons of ore, having a gross value of $291,787, from which $80,490 was deducted by the smelters for freight, sampling, assaying and smelting. The net smelters' returns were $211,297. The metal contents of the ore were 1,110,762 lb. copper, 3613 oz. gold, 188,905 oz. silver, and 3,738,773 lb. of lead.

The Utah Consolidated Mining Co., operating the famous Highland

[1] *Eng. Min. Jour.*, May 8, 1915.

Boy mine, had a very successful year. Dividends to the amount of $600,000 were distributed, as compared with $450,000 in 1913. During the year, 209,314 tons of ore was mined, as compared with 262,435, tons for the previous year. Earnings have been favorably influenced by the acquisition, during the year, of the International Smelting and Refining Co. by the Anaconda Copper Co.

The Bingham-New Haven, in Carr Fork, also had a successful year. The tonnage of ore milled was 38,917, concentrates from which came to 15,141 tons. Crude lead ore to the amount of 7270 tons was shipped to the smelter, while shipments of copper ore amounted to 10,586 tons.

An extra profitable year is indicated by the payment of dividends amounting to 75 cts. a share, of which 228,689 have been issued. Development work sufficient to keep pace with the extraction of ore has been carried on, and there appears to be a noticeable improvement in depth, particularly in gold content.

The United States Mining Co., in Upper Bingham, has operated its mines throughout the year with satisfactory results. A total of 193,962 tons of copper, lead, and zinc ore was shipped to the United States Smelting Co.'s plant at Midvale. Of this amount 101,687 tons was copper ore of smelting grade, without concentration.

OPERATIONS OF THE "PORPHYRY" COPPER COMPANIES IN 1914

	Utah.	Ray Consolidated.	Nevada Consolidated.	Chino.	Miami.
Ore reserves, tons	342,500,000	74,765,789	41,020,296	90,270,155	36,500,000
Average content copper, per cent.	1.45	2.214	1.75	1.75	1.85
Ore treated, tons	6,470,166	2,427,700	2,640,294	1,907,300	1,096,633
Average content copper, per cent.	1.425	1.76	1.48	2.12	2.28
Gross copper production, lb.	121,779,401	59,044,700	49,244,056	56,841,977	35,048,445
Average recovery, per cent.	66.04	67.88	68.48	67.86	69.93
Average copper in concentrate, per cent.	18.19	19.25	66.15	18.50	39.31
Average cost milling, cents per ton.	35.36	49.88	.....	55.01	49.96
Cost of copper, cents per lb.[1]	8.131	8.839	10.16	7.68	6.46
	7.245	8.763	9.82	7.35	.....
Gold production, oz.	34,729	.....	16,046	.....	.....
Silver production, oz.	325,351	.....	49,631	.....	.....

[1] First figure based on net production after making smelter deductions and applying credit for gold and silver. In second figure credit is applied for all miscellaneous income.

Wyoming.—The output of copper in Wyoming dropped from 362,235 lb. in 1913 to 17,082 lb. in 1914.[1] This small production comes from the Hartville district, chiefly; the Encampment district, and the Casper Mountain district in Natrona County produced a carload each of copper ore. Late in the year work was resumed at the Rambler Copper and Platinum Co.'s property at Holmes, Albany County. The mill was remodeled, and preparations were made to continue operations through the winter.

[1] Advance statement, U. S. Geol. Surv.

Copper Mining in Foreign Countries

Africa.—The output of the copper mines of Africa during the past year has increased somewhat in spite of the disturbing influences of the European war. The production in 1914, according to the figures of Henry R. Merton & Co., as reported in the *Engineering and Mining Journal*, was 24,135 metric tons, as compared with 22,870 tons in 1913. This increase is largely due to the increased output of the Katanga Co.'s mines. The production from the principal districts for the last 4 years is as follows:

AFRICAN COPPER PRODUCTION
(Long tons)

	1911.	1912.	1913.	1914.
Katanga	1,100	2,345	6,790	10,700
Cape Colony	4,480	3,870	3,220	2,420
Namaqua	2,500	2,500	2,500	2,250
Sundries	9,000	7,655	10,000	8,280
Total	17,080	16,370	22,510	23,650

In a circular letter issued by the Union Minière in December an estimate of the year's production was given out, and also a forecast of output for the coming 2 years. The production expected in 1915 is 25,000 tons, and in 1916, 40,000 tons. If these figures are realized the Katanga company will rank with the large copper producers of the world. The company's smelting operations at Katanga have been kept running without interruption, notwithstanding the decline in the price of copper from £60 to £48 per ton. Two furnaces were kept in blast and produced 3730 tons of copper up to the end of November. The third furnace was blown in at the beginning of December in order to increase the output of copper, as a result of the improvement in the price toward the end of the year. The copper produced from the beginning of the year to the commencement of the war was disposed of at a price that netted about £20 per ton, and that sold in London since the shipments to Belgium were interrupted by the war has netted £10 per ton. In order to further increase the output which is being stimulated as a result of the favorable outlook for copper, as shown by the increasing demand and the rise in price, the Katanga company is considering the erection of two additional blast furnaces which have already arrived at Beira, on the east coast.[1]

The Star of the Congo mine, situated 9 miles from the Lubumbashi smelter, produced in 1913, after sorting and washing, 50,000 tons of ore. The mine has been worked for some 3 years as an open cut with hand labor. Most of the ore is soft, but the fluxing dolomitic ore is broken up with 3¼-in. Ingersoll drills. Whites, employing gangs of negroes,

[1] Abstracted from *Min. Jour.*, Dec. 26, 1914.

contract some of the work; about 60 whites and 800 blacks are employed. The ore is now milled through to a haulage level from which the loaded cars are drawn to the adit mouth by cable. The coarse ore is dumped directly into railroad cars, the rest is washed, the coarser being then loaded, the rich middling briquetted, and the "fines" stored for future treatment. Talcose ores are treated in a special washing plant. Since January, 1914, two small Bucyrus steam shovels have, in addition, been stripping overburden and mining soft ore. The buckets are ½ cu. yd. and the shovels have a capacity of 200 tons per 10 hr.

At the Kambove mine, opened in June, 1913, there was produced, after sorting, in the last 6 months of that year, over 11,000 tons of ore. Two steam shovels, one a 48-ton Bucyrus, and the other a Koppel of 49 tons, each with dipper of 1½ cu. yd. capacity, have been shipped and were to have been ready to work early in 1915. Each has a rated capacity of from 500 to 600 tons per 10 hr. The mine is now worked by a main underground haulage-way to which the ore from the surface is shot down chutes. From this the ore is trammed by natives to a loading station, where the hard and soft ore is loaded direct into cars, the slightly cupriferous quartzite, on the other hand, being set aside for later treatment. The ore is sent by railroad to the smelter, where the soft is briquetted. About 30 white men and 400 negroes are employed.

Mining at the Luishia mine was retarded in 1913 by the inadequate labor supply, but nevertheless some 20,000 tons of ore was produced. As it is a powdery ore containing considerable cobalt and iron, the greater portion is briquetted. As the labor supply permitted, development was carried on at several of the mines, the next one to be opened presumably being the Likasie.

As noted above, much of the ore is soft, and to render this a satisfactory furnace product it is briquetted at Lubumbashi. The ore is compressed in a plant consisting of six presses, with a capacity of 250 tons per 20 hr., the pressure being 6 tons to the cu. in. The cylindrical briquettes, which contain no binder, are about 6 in. long and of 4 in. diameter. Concentration of the other ores now consists principally of hand sorting, although some ores are screened and washed, and the talcose ore is treated in log washers. A 50-ton mill is *en route* to Africa, and will be used for mill tests. A third water-jacket furnace was blown in on June 27, and in midsummer the three furnaces were simultaneously in operation, giving a daily production of about 48 tons of ingots, containing from 96 to 97 per cent. copper. It was expected prior to the war that four more would be blown in during 1915, and the two now *en route* and at Beira will presumably soon be erected.

The second battery of 22 Coppée coke ovens was completed in

March, 1914, and now from 3000 to 3500 tons of coke is made from Wankie (Rhodesia) coal. The waste gases are used to heat two Stirling boilers. As a little under 3 tons of coke is used per ton of copper produced, it is evident that these furnaces are sufficient for the present production, although the company also obtains coke from Wankie. A contract made early in the spring of 1914, intended to cover fuel necessary to feed further smelting units, dates from July 1, 1915, and runs 15 years. The coke price is satisfactory and low freight rates have been obtained from the Rhodesian railroads. The copper company engages to take at least 100,000 tons of fuel (at least 40,000 tons of coke, and not over 60,000 tons of coal) per year. The Wankie coal contains about 15 per cent. ash and 2 per cent. sulphur, and is washed to 10 per cent. ash and ¾ per cent. sulphur. The coke recovery is reported to be about 70 per cent. and contains 15 per cent. ash and about 1 per cent. sulphur. Clay and refractory bricks are also obtained at Wankie. Jean Jadot, chairman of the board, states that the cost for 1914 would be about 9.6 cts. per lb., delivered at Antwerp, plus approximately 0.4 cts. for general expenses in Europe. This price of 10 cts., of which 6.7 cts. is for mining and smelting, does not include debenture or amortization charges.

The labor situation is much less critical than a year ago, as late in 1913 a contract was entered into with the Nyasa Consolidated Co. to supply Nyasa natives, and natives are also being obtained from Portuguese West Africa.

The Namaqua Copper Co., operating mines at Concordia, in the western part of the Cape Province, South Africa, has had another successful year. The report for the year 1914 shows that 28,907 tons averaging 5.86 per cent. copper was raised from the Tweefontein mine, 4286 tons averaging 6.56 per cent. copper from the Henderson mine, and 1828 tons averaging 5.16 per cent. copper from the Wheal Julia. The smelter treated 34,871 tons, of which 10,210 tons was briquetted fine, and produced 3808 tons of matte containing 2250 tons of copper. At the leaching plant 113 tons of precipitate containing 78 tons of copper was recovered. The Elmore flotation plant treated 6648 tons of ore and tailing, of an unspecified assay value, for a yield of 530 tons of concentrate averaging 24.75 per cent. copper. The development at the mines has not been encouraging. The ore reserve on December 31 was estimated at 80,875 tons averaging 6 per cent. copper, a fall of 26,017 tons during the year. The accounts show a net profit of £30,070, out of which £23,582 has been distributed as dividend, being at the rate of 12.5 per cent.[1]

In the Transvaal the Messina Copper Co. is the only productive concern, and development operations during the past year have continued

[1] *Min. Mag.*, Apr., 1915.

favorable. The statistics of production of the Transvaal during the last 4 years, as published by the Union Department of Mines, show the rapid growth of the Messina Co. output, as follows:

	Tons.	Value.
1911	2,079	£48,237
1912	1,619	49,142
1913	5,289	138,328
1914[1]	4,046	98,454

Underground the mine continues to open up well. The No. 5 shaft has been sunk to the tenth level, a depth of 1000 ft. The No. 4 shaft, which is a twin vertical of No. 5, is now also being sunk to the tenth level, and when this has reached the same depth as its sister shaft, the No. 5 will be sunk deeper with a view of proving up the lenticular ore-bodies at still greater depth. The question of water supply, which has occasioned the management some anxiety, was solved some little time ago by a very heavy rainfall, and there is now abundant water in the Zand River, from which the company derives its water supply.

The report of the Bwana M'Kubwa Copper Co., of Rhodesia, up to June 30, 1914, showed a balance of cash on hand of £60,132, of which £56,964 was realized on concentrates shipped during the last year, previous to June 30. The total developed footage in the mine now amounts to 12,841 ft. The concentration plant has been in continuous operation during the year, and a total of 2221 tons of concentrates containing 1046 tons of copper was produced.[2]

The Otavi Mines and Railway Co., German Southwest Africa, has had a successful year. The profits from mining operations and from working the railway for the government for the last 3 years has been as follows: 1912, £134,188; 1913, £191,015; 1914, £208,310. The company's mining operations are conducted in the main at the Tsumeb deposit, where at first the ore was obtained by open-cut, but where for some time past it has been secured by ordinary mining operations of shaft and driving. The mine has now been opened to the fifth level. At this level development work has proved the ore-bodies to be considerably more extensive than at the fourth level and the grade in no way inferior in quality to that in the higher levels. The main shaft has been put down to the sixth level, and there commencement of driving has been started. Exploring below the fifth level by two bore holes and a winze has ascertained continuity of ore in depth with lead and copper contents. The shaft is to be continued down to the seventh level. Erection of plant for concentration of ore, also screening and picking, has been going on, and such plant will come into operation shortly. The procedure of

[1] Figures for the first quarter only.
[2] *So. Afr. Min. Jour.*, Jan. 16, 1915.

the company is to effect shipments of the rich ore, also locally concentrate and smelt low-grade material.

The output of the Cape Copper Co. during the past year has decreased about 800 tons, owing to a rearrangement of the smelting plants and to a lower price obtained for copper. The net profits for the year are given as £17,244. In the Nababeep mine the ore reserves have been increased from 150,000 to 160,000 tons through the discovery in the western part of the mine of a new body of ore of somewhat richer copper content than the average run of the mine. The O'okiep mine, which is very low in ore reserves, has continued to produce with no apparent diminution of reserves. The Rakha Hills mines will add considerably to the company's output of copper, although some time must elapse before the plant will be ready to treat the large tonnage already developed. The results of the development work during the year were satisfactory, for not only was there distinct evidence of improvement of grade in depth at the No. 1 shaft, which was then about 900 ft. deep, but also lateral extension of the lodes was shown, with wider ore-bodies, at the No. 4 shaft, 3500 ft. distant from the No. 1. The development during the year had increased the ore reserves by 68,542 tons, having practically the same average assay value as the ore previously proved. The ore in reserve at both shafts, fully or partially developed, amounted at the end of August to 307,747 short tons, the gross copper contents of which worked out at over 12,000 short tons. All effort was now directed to the completion of the plant, which would enable them to begin production.

Asia Minor.—The Ottoman government is reported to have decided to sell the copper mines of Arghana in Asia Minor, which have up to the present been exploited by the Ministry of Public Works. Many financial groups have desired to obtain the concession; the Deutsche Orient bank has offered an advance of a million Turkish pounds, and it is reported that an English firm has proffered £1,600,000. The mines are situated in the Province of Diarbekir. The aggregate volume of the cupriferous deposits is estimated to be 1,200,000 tons, principally pyrites, averaging 15.65 per cent. of copper.[1]

Australasia.[2]—The production of copper in Australasia during 1914 was 37,592 metric tons,[3] as compared with 47,325 tons in 1913. The decrease in output is due to the effects of the European war on the copper industry the world over, causing a failure of the market and a reduction in the price.

For the first 6 month of the year, the price of electrolytic copper was well over £60 per ton, and under normal conditions there was every

[1] *Min. Jour.*, July 25, 1914.
[2] Abstract of review by W. P. Geary, *Eng. Min. Jour.*, Jan. 23, 1915.
[3] As reported by Henry R. Merton & Co.

reason to expect that the price would maintain a fairly high average, which would stimulate copper mining to a great extent in Australia.

Queensland produced 18,436 tons this year, the chief producers being the Mt. Morgan and the Cloncurry fields. The Chillagoe, Ltd., closed down its smelteries early in the year, owing to the high cost of fuel and the slow progress made with the construction of the railway at Mt. Mulligan, whence the Chillagoe company intended drawing its supply of fuel. The Mt. Elliott, Ltd., has also closed its smelteries, being only engaged in development work at present, while the Great Fitzroy mines have been closed for the greater part of the year.

The Mammoth copper mine in north Queensland, which promised so well in the early part of the year, has had to suspend smelting operations through the effects of the war.

Western Australia should account for about 750 to 1000 tons, the principal copper fields being the West Pilbarra and Phillips River. In the latter district, the state government has recently erected smelteries for producing blister copper.

The properties in New Guiana are still in the prospecting stage and their production does not seriously affect the output of Australia.

New South Wales.[1]—The value of the output of the copper mines of the state for the year is estimated at £274,671. This is £324,062 in value less than in the preceding year, and is the lowest value recorded for the production since 1898. One of the chief causes of the lessened output for the period under review was the closing down of the smelters at the Great Cobar mine on April 9, 1914, and to date operations have not been resumed. Other important mines, such as Cadia, Lloyd (Burraga), Grafton (Cangai), and those in the Dandaloo and Nymagee divisions suspended work on the outbreak of the war, and the production from these sources was affected accordingly. The value of the output from the Cobar district, which is the principal center of the copper mining industry, was £116,460, as compared with £391,914 for the year 1913, or a decrease of £275,454. At the works of the Electrolytic Refining & Smelting Co. of Australia, Ltd., Port Kembla, the production of metals during the year included 17,570 tons of electrolytic copper, which was chiefly obtained by the treatment of mattes and ores imported from Queensland and other states, only a small proportion being won from the products of the mines of New South Wales. The value of copper produced in the state to the end of 1914 is estimated at £12,657,506.

South Australia.—The copper production of South Australia in 1914 amounted to 6881 tons, as compared with 7161 tons in 1913. The most important mines in South Australia are those of the Wallaroo and

[1] *Austral. Min. Stand.*, Apr. 8, 1915.

Moonta Mining & Smelting Co. According to the report of the general manager for the year 1914, satisfactory progress attended operations until the war broke out in August. The policy of exploration and development outlined in the annual reports for 1912 and 1913 as necessary for the maintenance of the regular output of ore was vigorously pursued throughout 1915, except for 3 weeks following the outbreak of the war, when some difficulty was met in financing the company's operations. Temporary arrangements with the South Australian government and a 10 per cent. retention of wages did not fully meet the case and, with the drop in the price of copper, it was found necessary to make a 20 per cent. deduction from salaries and wages on Oct. 1.

The Wallaroo mines during 1914 produced 56,365 metric tons of ore containing 5221 tons of fine copper, or an average of 9.26 per cent. The ore tonnage in 1913 was greater but the copper content of the ore was less, so that the copper output in 1914 was 37 tons greater than that of the previous year. The Moonta mines showed an increase in ore production over the 6421 tons in 1913 to 7467 tons net in 1914. The copper extracted from these ores for the 2 years amounted to 789 and 1148 tons respectively, and the average percentages of copper for the same 2 years were 12.29 and 15.37. The cementation plant of the Moonta mines produced 738 tons of copper from treating 942 tons of copper

PRODUCTION OF COPPER IN AUSTRALASIA
(In tons of 2240 lb.)

Year.	New South Wales.				Queensland.		South Australia.		Tasmania.			Western Australia.			Combined Value.
	Ingots, Matte and Regulus.		Ore.		Copper, Tons.	Value.	Copper, Tons. (a)	Value.	Blister copper.		Copper ore.		Copper ore, Tons.	Copper Tons. (b)	
	Tons.	Value.	Tons.	Value.					Tons.	Value.	Tons.	Value.			
1907	8,963	£716,759	1,135	£11,015	12,756	£1,028,179	7,931	£690,000	8,247	£832,691	788	£36,975	3,727	1,602	£203,376
1908	8,679	496,564	392	6,248	14,961	893,535	5,628	338,000	8,833	603,063	1,185	6,588	2,503	479	57,091
1909	6,857	423,642	109	1,095	14,494	853,196	5,697	334,584	8,638	586,419	1,588	21,619	6,959	833	104,644
1910	8,435	450,491	4,455	35,766	16,387	932,489	5,102	306,120	8,193	553,822	671	13,150	6,309	1,281	95,928
1911	10,618	578,198	1,482	11,904	20,384	1,151,351	5,922	332,500	6,022	385,797	2,286	22,852	9,825	829	78,364
1912	8,990	560,025	2,044	19,766	23,120	1,698,280	6,295	461,500	5,136	430,965	1,392	9,479	13,607	1,703	120,158
1913	9,153	595,826	308	2,907	23,655	1,660,178	7,161	488,986	4,569	364,332	1,907	10,932	(c)4,339	(c) 82	145,513
1914	3,500	274,671	.....	.....	18,436	.....	6,881	417,487	7,509	477,361	3,288	18,680	.....	.....	.....

(a) Small amounts of copper ore and sulphate not included here. (b) Ingots and matte. (c) Exports.

ore, or 78.36 per cent. This is a better showing than was made in 1913, and the increased output is ascribed to improvements that have been made in the slime treatment. The Wallaroo smelting works treated 56,466 tons of ore, matte, and precipitate from the Wallaroo and Moonta mines, and obtained 7022 tons of refined copper, 2702 oz. gold, and 2936 oz. silver. The quantity of bluestone made was 3¾ tons.

The cost of producing the refined copper and placing it f.o.b. ocean steamer, including mining, smelting, repairs, maintenance, shipping charges, and office expense, amounted to £51 18s. 3 d. per ton, as compared with £56 15s. 10d. for 1913. The principal saving in production cost during the past year was due to cheaper mining and smelting.

The vein stuff raised during the year from the Wallaroo mine was 126,290 tons having an assay value of 3.967 per cent. copper. The concentrating plant at Devon treated 56,845 tons of vein material from underground and 67,368 tons of re-treatment material from the waste dump. The recovery of copper for the past 3 years was 80.8, 88.1, and 94.0 per cent., respectively. The Moonta mines hoisted 30,708 tons of vein stuff having a copper content of 3.761 per cent.

Tasmania.—The Mount Lyell company is the largest producer in Tasmania. The estimated production for 1914 was 7500 tons of copper, of which the Mt. Lyell company produced 7168 tons, and the remainder is due to the only other copper mine of any consequence, Murray's Reward.

The total tonnage of ore and metal-bearing fluxes mined by the Mt. Lyell M. & R. Co. during the half year ended September 30 was 171,250 tons, as compared with 169,857 tons for the previous half year; this included 105,283 tons from the Mt. Lyell and 65,819 tons from the North Mt. Lyell mines. No calculations of reserves have been made this half year, but they are estimated at 1,991,789 tons at the Mt. Lyell, assaying 0.531 per cent. copper, 1.96 oz. silver, and 0.0275 oz. gold, and 959,832 tons at the North mine, assaying 6 per cent. copper, 1.33 oz. silver, and 0.005 oz. gold. The output for the half year was 3864 tons copper, as compared with 3391 tons in the previous term, 5280 oz. gold, against 3391 oz., and 230,592 oz. silver, against 231,740 oz., and the cost of producing the blister was £1 1s. 2.53d., against £1 0s. 4.01d. per ton, an increase of 10.52d. The net profit was £29,317, as compared with £61,954 in the previous half year. At the end of the previous half year 821 tons of copper remained unsold, and was taken into account at £60 per ton. This was sold at an average of £63 13s. 11d. Of the 3864 tons of refined copper since produced, 1547 tons was sold (1400 tons after the declaration of war) at an average of £52 18s., leaving 2317 tons unsold September 30, which is taken into account at £50 per ton. Since

the accounts were made up further sales have been made, amounting to 750 tons, the average price realized being £52.

At the North Lyell mine ore production continues on normal satisfactory lines, with the output keeping at between 10,000 and 11,000 tons a month, and the average grade right up to 6 per cent. At the 1100-ft. level, No. 41 stope ore-body is still yielding an appreciable tonnage of high-grade ore. They are pushing ahead as fast as possible with the sinking of No. 2 engine winze, but the extremely hard nature of the country is against anything like good progress. The depth to date is about 80 ft., progress being at the rate of about 4 ft. a week. At the 1000-ft. level very good grade ore continues to be won from No. 40 stope on its northerly ground floor extension into the Comstock area, while the stopes at the 925-, 850-, and 700-ft. levels are all maintaining excellent value.

At the Mount Lyell mine they are making fair progress with the deepening of the main shaft and a depth of about 55 ft. below No. 8 level has been reached. The extraction of pyrite for smelting requirements is going on at the rate of between 16,000 and 17,000 tons a month, most of this coming from underground.

Austria.—Copper production of Austria in 1913 was as follows, according to a consular report from Vienna: Of 32 works for producing copper ore, 10 mills, with 26 overseers and 753 workmen, were in operation in Austria in 1913. About 163,533 quintals (quintal = 100 kg. or 220.46 lb.) of copper ore, valued at 1,542,296 crowns ($313,086), was produced. In this output, which shows a decrease of 5.76 per cent. compared with the preceding year, the government mines furnished 2.36 per cent. and the mines under private ownership, 97.64 per cent. The mills produced 36,845 quintals of metallic copper, valued at 5,986,409 crowns ($1,215,241). Copper works controlled by the mining authorities produced, besides copper, speiss and copper regulus, 8966 quintals of copper vitriol, valued at 514,970 crowns ($109,806). The entire production of the province of Tyrol, 95.36 per cent., is controlled by the government, and the full yield of the province of Salzburg, 4.64 per cent., by private works.

Bolivia.—Corocoro is the most important copper district of Bolivia. It is now connected with the coast of the new Arica-La Paz railroad, and is 339 km. from the port of Arica. During 1914 the production of copper in Bolivia was 2743 metric tons, as compared with 3,658 tons in 1913. The decrease was due to the European war as the *barrilla*, a high-grade ore containing about 84 per cent. copper and obtained from the native copper deposits, has formerly been shipped to Europe, but since the outbreak of hostilities shipments have ceased.

The Arica railway has brought about a considerable development in

Corocoro during the last year. Before this railroad was built, the *barrilla* was sent to the coast through the port of Mollendo in Peru; the journey was long, required various transfers at Lake Titicaca and at the Rio Desaguadero. To-day the *barrilla* is loaded in railroad cars in Corocoro and goes directly to the docks at Arica, with the great advantage of no breaks in the sacks or other important losses. Another of the great advantages of the railroad to Arica is that to-day the copper sulphides that occur abundantly in the veins can be exported without concentration.

The district contains many copper veins; for more than 100 years only the native copper ore has been worked. The sulphide veins were not touched because it was impossible to export the crude sulphide ore by way of Mollendo, on account of the difficulties of transport. At times there were not enough llamas and at other times the Rio Desaguadero contained very little water and, of course, the freighting was expensive.

The native-copper veins also contain ruby copper ore (Cu_2O); the *yanabarras* veins, as they are called in Corocoro, are accompanied by green sulphates. The *yanabarras* are the black sulphides without iron that correspond to chalcocite (Cu_2S) and are found in an arsenical gangue. The sulphide ores lend themselves to concentration; but this company has limited its efforts to the exportation of *yanabarras* and sulphates carrying 18 per cent. or more. There are veins of *yanabarras* that have a width of 9 m. with an average grade of 5 per cent. These are not yet touched, as the company hopes first to study a method of concentration. The Cia. Corocoro of Bolivia was exporting in November at the rate of 1500 tons monthly of ore having a grade of 18 per cent. The green sulphates of copper have little depth and at a few meters one encounters the unoxidized *yanabarras*.[1]

Canada.—The copper contained in matte, blister copper, etc., produced in Canadian smelters, together with the estimated recoveries or amounts paid for in ores exported, amounted in 1914 to 75,738,386 lb. which, at the average New York value of refined copper, would be worth $10,301,935. Compared with the production in 1913, which was 76,976,925 lb., valued at $11,753,606, there was a falling off of only 1,238,539 lb., or 1.6 per cent., but, owing to the lower price, a much larger percentage decrease in total value. The production by districts was as follows:

CANADIAN COPPER PRODUCTION
(In pounds)

	(*a*) 1911.	(*a*) 1912.	(*b*) 1913.	(*b*) 1914.
Quebec	2,436,190	3,282,210	3,455,887	4,201,497
Ontario	17,932,263	22,250,601	25,884,836	28,948,211
British Columbia	35,279,558	50,526,656	45,791,579	41,221,628
Yukon	.....	1,772,660	1,843,530	.....
Total	55,648,011	77,832,127	76,975,832	75,738,386

(*a*) Min. Prod. of Canada for 1912, Ottawa, 1913. (*b*) Min. Prod. of Canada, Preliminary Report for 1914, Ottawa, 1915.

[1] Corocoro Copper District, Bolivia, *Eng. Min. Jour.*, Jan. 23, 1915.

The production in Quebec from pyritic ores was 4,201,497 lb., as compared with 3,455,887 lb. in 1913. The actual copper content of the ores shipped was nearly 50 per cent. in excess of these figures, but only about two-thirds of the copper is reported as paid for.

The Ontario production is derived chiefly from the nickel-copper ores of the Sudbury district and of the Alexo mine, although there is a small amount of copper contained in the silver ores shipped from Cobalt, some of which is paid for. There was also a small shipment from the Dane mine on the T. & N. O. railway.

The production in 1914 is reported as 28,948,211 lb., an increase of 3,062,282 lb. over the 1913 output, which was 25,885,929 lb. The Mond Nickel Co. contributed a much larger percentage of the total production during 1914 than in 1913, and as this company's ores are higher in copper than those being worked by the Canadian Copper Co., we have the perhaps somewhat unexpected result of a decrease in nickel production accompanied by an increase in copper production from these Sudbury district ores.

Nickel contents of Bessemer matte are estimated at 22,000 tons, worth $4,900,000, and copper contents 14,250 tons, worth $2,000,000. The Canadian Copper Co. some time ago believed its great Creighton mine was approaching the point of exhaustion. Consequently, the huge but lower grade deposit known as Frood, or No. 3, mine was opened up, a town was built by the company for its workmen, and operations on a large scale begun. The diamond drills which meantime had been exploring the Creighton, reported the existence of large reserves previously unknown. Work was stopped at the Frood, and again the company is drawing its main supply from the Creighton mine. The Alexo mine in Dundonald township, which had been shipping ore to the Mond smeltery, discontinued consignments when war was declared, but has since resumed them.

The British Columbia production was 41,221,628 lb., as against 45,791,579 lb. in 1913, a falling off of 4,569,951 lb. The Greenwood smelter closed down in August and the Grand Forks smelter restricted its operations very severely on the outbreak of war, but started up several furnaces again before the close of the year. The blowing in of the smelter at Anyox, treating the Hidden Creek and other coast ores, and the continuance of large shipments from the Britannia mine made the coast production slightly greater than that of the southern interior smelters and, with an increased production at Trail, almost compensated for the falling off in the Boundary district.

The British Columbia Copper Co. blew out its plant in August, and also shut down its mine. At its Mother Lode mine in the Deadwood

camp, about 178,000 tons of ore was mined, at the low figure of 85.48 cts. on board cars. A slight increase in cost here is due to the necessity of mining more ore by stoping instead of by glory-hole methods. Up to Aug. 20 the company had smelted 295,000 tons, of which 191,000 was company ore, the balance being custom ore. Something over 4,000,000 lb. of copper was produced, 14,442 oz. of gold and 63,501 oz. of silver. The company is operating a group of claims with about 25 men at Copper Mountain, 12 miles south of Princeton, in the Similkameen district. The result of the work here indicates a reasonably assured reserve of 5,000,000 tons and more, with excellent chances for this to be increased. The Granby closed down its Phoenix plant somewhat earlier than did the British Columbia, but resumed operations again on a reduced scale; it is rumored that a gradual increase to full capacity is planned. The Consolidated Mining & Smelting Co., at Trail, resumed the acceptance of shipments in October, making partial payments for the contents of custom ore with arrangements for later complete payment.

The copper production of the coastal district shows a remarkable increase for the year 1914 over that of previous years, as shown in the following table covering the last 5 years.

COPPER PRODUCTION OF THE COASTAL DISTRICT[1]

	Lower Coast, Lb.	Portland Canal Skeena, Queen Charlotte, etc., Lb.	Total, Lb.
For 1910	3,078,090	.....	3,078,090
For 1911	10,998,721	19,151	11,017,872
For 1912	15,429,778	88,403	15,518,181
For 1913	14,443,793	3,174	14,446,967
For 1914	13,070,245	11,129,376	24,199,621
Totals	57,020,627	11,240,104	68,260,731

Of the total production of copper in the Coastal districts during the last 5 years, 36 per cent. was produced in 1914, in which year the output was more than 50 per cent. larger than in any other year since a beginning was made to produce copper from mines in this district. It should be noted that nearly all of the 1914 production was made at two mines—the Britannia, near Vancouver, and the Hidden Creek, on Observatory inlet. Neither of these mines, however, was worked to capacity last year, war conditions having prevented, so that when normal conditions shall be restored it will not be unreasonable to expect an output from them of 40,000,000 to 45,000,000 lb. of copper a year, without including the output of several much smaller mines that will probably also be producers in the near future.

The total quantity of copper produced in the province in all years, as shown in the official records of the British Columbia Department of

[1] *Can. Min. Jour.*, May 1, 1915.

Mines, was 503,737,902 lb. Of that total approximately 65,251,000 lb. was from what is officially known as the Coast district, and 1,721,000 lb. from mining divisions included, officially, in Cassiar district. If there be added to the total of the whole province the production of 1913 and 1914, say 91,460,000 lb., a grand total for all years of, in round figures, 595,198,000 lb. will be obtained. It is noteworthy that more than 50 per cent. of that total was the production of 7 years, 1908–1914.

The Pueblo mine was again the principal copper producer in the Yukon with an output only slightly less than that in 1913.

The New York price of electrolytic copper fell off from 14.7 cts. in February to 12.7 cts. during the last week of July. Quotations ceased on the declaration of war but were resumed in November at a little over 11 cts., increasing to 13.2 cts. in December. The average monthly price for the year was 13.602 cts., as against 15.269 cts. in 1913, and was with the exception of 1912 and 1913 the highest average since 1907.

There was a large falling off in the imports of copper of all kinds in 1914. The total imports were valued at $4,256,901 and included crude and manufactured copper, 28,280,812 lb., valued at $3,983,322, copper sulphate, 1,143,039 lb., valued at $53,802; and other manufactures of copper, valued at $219,777. The total imports in 1913 were valued at $7,415,008 and included crude and manufactured copper, 41,011,961 lb., valued at $6,935,822; copper sulphate 2,037,714 lb.,valued at $107,960 and other manufacturers, valued at $371,226.

The exports of copper were: copper fine in ore, matte, etc., 68,830,059 lb., valued at $7,130,778; and copper black or coarse, etc., 6,581,564 lb. valued at $908,201; a total of 75,411,623 lb., valued at $8,038,979.

Chile.—The copper production of Chile during 1914 was slightly in excess of that of the previous year, the figures for the 2 years being 40,876 and 39,434 metric tons, respectively. Of last year's production the United States received 23,814,659 lb. of blister copper and 29,056,280 lb. in the form of ores. England and France received 37,244,960 lb. during the year, making the total of exported copper from Chile 90,115,899 lb. in 1914, as compared with 86,936,945 lb. in 1913. The production for the last 2 years as shown by the exports to the United States and Europe is shown in the following table:

COPPER PRODUCTION OF CHILE[1]
(In pounds)

	1913.	1914.
Blister copper to the United States	18,315,000	23,814,659
Copper in ore to the United States	24,911,465	29,056,280
Copper to England and France	43,460,480	37,024,960
Sundries	250,000	220,000
Total lb.	86,936,945	90,115,899
Total metric tons	39,434	40,876

[1] *Eng. Min. Jour.*, Revised Statistics, April, 1915.

At the Chuquicamata and Braden copper mines work was not abated on account of the war or the financial stress arising therefrom. Most of the smaller copper companies curtailed operations after August and some stopped completely. Exceptions to these were the Catemou, Naltagua, Chañaral, and the Copiapo companies and the Central Chile Copper Co., at Panulcillo, where important improvements were made, outlying properties optioned and a new power plant erected; in the north, at Collahuasi, the Poderosa and the Société Francaise des Mines de Cuivre mined their high-grade ores; the French company erected a small experimental plant to concentrate the low-grade siliceous ore now on the dumps. The Braden Exploration Co. explored its Potrerillos group of copper claims, about 90 miles back from Chañaral, and also made preliminary examinations of two properties in the vicinity of Santiago.

The enterprise of the Chile Copper Co., at Chuquicamata, was prosecuted vigorously in 1914, between 2000 and 3000 Chileans being employed on the work besides 200 or 300 Americans and Europeans. The prostration of the nitrate industry, owing to the European war, threw many laborers out of employment and furnished the Chuquicamata mines with an abundant supply of labor, enabling construction work to go forward with such expedition that the operating officials at the end of 1914 estimated that the plant would be ready for operation about Mar. 31, 1915. The equipment for the power station at the port of Tocopilla and for the electric substation at the mill was made in Germany, and when the war broke out a large part of this equipment was on board more than a dozen English and German steamships afloat in the Atlantic and Pacific Oceans, and part of it was still in Europe; fortunately, however, neutral ships were obtained and all of this material was gotten out of these steamships and out of Germany, and most of it is delivered. All of the equipment for the railway, the transmission line and the mine and some of the mill equipment was made in the United States and the installation of same was nearly completed. Officials of the company state that Chuquicamata is now the largest known deposit of copper in the world, and expect before long that it will be the largest and cheapest producer of copper in the world. The development of the mine by drills was continued in 1914 and the tonnage developed now exceeds 300 million; the exact amount reported by the company's engineers on Dec. 6, 1914, was 297 million tons, averaging over 2 per cent. copper.

The Braden Copper Co. continued its operations, increasing its developed tonnage and improving its metallurgical treatment. At the end of December, 1913, Consulting Engineer Pope Yeatman reported 78,000,000 tons of 2.5 per cent. copper ore, classified as developed, probable, and possible; the work of 1914 materially increased this tonnage.

The company produced at the rate of about 2,400,000 lb. of copper per month. One of the features of the metallurgical improvement was the installation of the preliminary nodulizing kiln, of which three were shipped; the first kiln did good work and led the company to anticipate satisfactory results in preparing the flotation concentrates for treatment in the blast furnaces.

The Gatico Copper Co. has for many years past steadily increased its production until at present it furnishes about 6 per cent. of the total output of Chile. In 1914 the production of this company was 2,414,506 kg. of converter bars, containing 98.5 to 99.5 per cent. copper.

China (By T. T. Read).—The domestic production of copper in China, chiefly from Yunnan and Kweichow provinces, is considerable, as is evidenced by a recent report from Wuchang that an order for 10,000-000 lb. for carriage purposes had been placed. All the mining and smelting is in the hands of natives, and no authentic records are kept. A company called the Ching Hua Mining Co. has recently been formed to develop a copper mine in the Nanchang district of Hupeh. Nothing has been heard recently of the smelting plant erected near Lanchow in Kansu, nor of the mines at Chang-pai-ling, in Kiangsi. At Pai-Shui-ho in Ssuchuan, a Chinese company is at work. The chief production from Ssuchuan comes from the government mines at Hui-li-chou, worked by native methods.

Copper mining also shows considerable development in Korea. The most important area is that comprised in the Kapsan concession, about 60 miles from the port of Songchin, on the east coast in north-eastern Korea. The concession embraces about 4000 sq. miles, and has been under development since 1909. Proposals for the erection of a smelting plant of a capacity of 100 tons of ore per day were under consideration before the outbreak of the war. The mine was worked by the Koreans on a small scale for many years. There is small but increasing export of iron ore to Japan, which last year amounted to nearly 150,000 tons. It is understood that the Mitsu Bishi Copper Co. is considering the erection of smelters in Korea itself.

Cuba.—During 1914 Cuba exported to the United States ore and matte which contained 18,659,788 lb. of copper. This production comes chiefly from the El Cobre mines, a short distance west of Santiago. From 1839 to 1860 this property produced 788,880 tons of high-grade ore valued at $30,000,000, under the management of an English company. Since then the mine has been flooded and entirely abandoned, until after the Spanish-American war an American company obtained possession. Pumping operations for unwatering the mine were at once started on a very large scale, and a railway to the port of Santiago was built. The

workings have not yet been pumped dry down to their old depth, and meanwhile mining is restricted to the poorer ores left by the old owners as unpayable. These average from 3.50 to 4 per cent. Cu. The output is concentrated by the Minerals Separation, Limited, flotation process, which is stated to give excellent results. The production, totalling about 50,000 tons concentrates and rich ores, is shipped for further treatment to the U. S. A. Whether the richness of the El Cobre lode will continue in depth remains, of course, to be seen. The El Cobre ores mainly consist of copper pyrites and copper glance.[1]

Germany.—As a result of the policy adopted by England with respect to the importation of copper or copper-bearing ores into Germany, that country has been cut off from every outside source of supply of copper and a very interesting condition has arisen. The following is a German view of the copper situation expressed in a report of the American Association of Commerce and Trade in Berlin, Dec. 19, 1914.[2]

It has been frequently said that the interruption of the copper import into Germany is a serious menace to her industries. Notwithstanding the fact that Germany produces only 2.4 per cent. of the world's copper production, which has a volume of 1,000,000 tons per year, no conclusion should be formed upon the resources of copper for Germany. In the first instance, with the interruption of the import the exports also ceased, and, therefore, all the copper formerly used for exports in manufactured form is available. Furthermore, it is almost an impossibility to prevent the importation of copper entirely.

The following industries have the greatest interest in the pending copper question; manufacturers of ammunition, vessels of all sorts, apparatus for breweries and distilleries, plates for copper printing, manufacturers of bronze and brass ware, electrical industries, parts for the chemical industry, etc. A distinction should be made as to the uses of copper for these various industries, referring to refined copper of the best quality and ordinary copper as is utilized in many instances for various purposes.

In order to insure the supply for the army and navy, the authorities have taken the supervision into their hands in regard to the trade in refined copper. There are large quantities on hand of ordinary copper in the form of scrap copper, sufficient for the yearly demand of 8 lb. per capita, which is the same amount that is used, as per statistics in times of peace. The German copper coins alone represent a weight of approximately 8000 tons; many copper products becoming unserviceable are

[1] The Occurrence of Copper and the Mines at El Cobre, Cuba. E. Neuman, *Metall u. Erz*, pp. 221–6, 1913.

[2] *Eng. Min. Jour.*, Jan. 30, 1915.

being remelted and the copper used over again. It was these reserves that caused the failure of the copper corner in 1889.

Germany can be considered a vast copper mine from the fact that it has been imported in enormous quantities and retained in the country in many forms of manufactured goods.

According to official data, the import of copper into Germany in 1913 amounted to 220,892 tons and the German copper production to 40,278 tons in the same year. The yearly copper import into Germany represents a quarter of the entire world's production and within the last 10 years nearly 2,000,000 tons has been imported.

In view of these facts it is not surprising that Germany, after four months of war, is in a position not only to satisfy all demands of her army and navy, but largely those of her industries.

The German production of electrolytic and blister copper has multiplied in comparison with former years, and is steadily growing, even during the present war. Existing plants for the production of refined and blister copper are being enlarged, as large quantities of scrap copper, filings, residues containing copper, are being delivered, attracted by good prices, material which in time of peace was largely sent to Belgium, England, and France. On the other hand, copper is being replaced wherever possible by other suitable material, as for instance, copper-covered material is now used for many purposes, where formerly pure copper was used.

A statement issued by the German Press Bureau at the end of November gives the production of copper from domestic ores at 45,000 metric tons, and states that the mines at Mansfeld, Eisleben, and Hettstadt are being worked day and night. These figures do not correspond with what is known of German domestic production. The output from domestic ores and intermediate products was estimated last year at 25,000 metric tons. Indeed, the total production, including all imported raw material, is estimated at 41,000 metric tons for last year. Imported pyrites would furnish the source of the great bulk of the copper thus recovered, and as practically the whole of it is derived from Spain, Portugal, Norway, and France, it is difficult to see how any ore except that already in stock can be available.[1]

Japan (By J. Kojima).—The estimated production of copper in Japan for 1914 is approximately 77,000 short tons,[2] which is about 5 per cent. greater than the output of the previous year. The increase would have been much greater had the European war not interfered and caused a marked curtailment during the latter part of the year. During the last

[1] *Min. Jour.*, Dec. 19, 1914.
[2] Advance statistics, Bureau of Mines, Japan.

few years the copper industry of Japan has made very remarkable advances and under favorable conditions for the coming year the production should go over 80,000 tons. The ore reserves are steadily increasing in the well-developed mines, and virgin territory has been carefully prospected with satisfactory results. Modern equipment is rapidly replacing the older machinery of the mines and reduction works, which is making possible the mining of low-grade ores long ago abandoned as worthless.

The following table gives the production of the principal mines for the last 4 years:[1]

COPPER PRODUCTION OF PRINCIPAL JAPANESE MINES
(In tons of 2000 lb.)

	1911.	1912.	1913.	1914.
Ashio	8,483	10,530	9,335	10,631
Kosaka	6,606	8,867	6,660	7,520
Hidachi	6,243	8,704	9,835	10,132
Besshi	7,573	8,537	7,523	7,446
Ozaruzawa	2,172	2,385	2,062	2,087
Ikuno	1,654	1,884	1,801	1,998
Furokura	2,014	1,719	.....	.....
Ogoya	1,246	1,540	1,441	1,482
Arukawa	1,410	1,413	1,056	919
Kamaishi	.....	.....	1,152	1,167
Ani	.....	.....	1,137	1,373
Other mines	20,252	23,299	9,749	10,691
Total	57,653	66,878	51,751	55,645

As shown by the production figures, the leading mines are the Ashio, Hidachi, Kosaka, and Besshi, and the owners of these also have smelters and concentrating plants.

The Ashio mines and smelter are owned by Furukawa & Co. The ore occurs in innumerable veinlets that intersect each other, and consists of the copper minerals, chalcopyrite and bornite, with various gangue minerals.

The mines are provided with 10 vertical shafts, measuring 6845 ft. in aggregate length, and have drifts that total more than 130 miles in length. The average yearly development work amounts to about 150,000 ft. Mining is carried on with up-to-date equipment, water power being used to drive air compressors and electric generators that supply light and power for hoisting and underground purposes. Four compressors each with a capacity of 1740 cu. ft. per minute supply the air for running the drills, etc.

The smelter is provided with three blast furnaces, three converters, seven pot roasters, two McDougall furnaces with power-blowing engine and turbo-blower, and is fed principally with concentrates that average

[1] Figures for 1913 and 1914, *Eng. Min. Jour.*, **99**, No. 19.

11 to 12 per cent. copper. In 1914 the yield of copper was 23,827,030 lb. copper, containing 321,708 oz. silver, and a small amount of gold.

During 1914 railway connection was made from the large cities to the mines through the steep canyon of Watarase River, and in the fall it was extended to the smelter plant. More than a dozen aerial trams measuring 26 miles in total length are used for the transportation of waste, slag, limestone, timbers, etc.

The second largest producer of copper is the Hidachi group, owned by the Kuhara Mining Co. The ore consists of cupriferous pyrite which occurs in lenticular masses in Paleozoic clay slate and schistose rocks. The copper contents of the ore varies from 2 to 5 per cent., and the ore is sent to the smelter mostly without concentration.

The smeltery has 27 pot roasters, 2 reverberatory furnaces, 8 open-top blast furnaces, 4 converter stands, 5 Root's blowers, and 4 turbo-blowers. The converters are of the barrel type, having a diameter of 78 in. and a length of 96 ft. The output of the plant in 1914 was 22,708,-580 lb. of copper, of which 60 per cent. represents the copper content of company ores, and the rest was custom ore. Siliceous ores from the outside are welcomed, as silica is needed to flux the company's ores. The smelter is unique in having the largest smokestack in the world, being 511 ft. high and having a diameter of 50 ft. at the base.

The Kosaka mines and smelter are owned by Fujita & Co., of Kosaka, Akita, and rank third in copper production. The ore occurs in massive form and consists of a complex of the sulphides of the base metals, formed by metasomatic action along a contact zone. It averages 2.3 per cent. copper and carries values in gold and silver along with 2.4 per cent. lead and 12.7 per cent. zinc. Mining is carried on in open cut as at Bingham, Utah, more than a dozen terrace levels being worked at the same time. It is supposed that the richer parts of the ore-body have been mined out, and a somewhat leaner ore zone surrounding the older workings, and of great size is now furnishing the low-grade material from which the values are recovered by careful milling processes. The mills of the company have in course of construction a daily capacity of 3000 tons.

The Kosaka smelter receives the concentrates from the mill and treats in addition almost an equal amount of custom ore from other mines. The output of the smelter in 1914 was 16,854,560 lb. of copper, 963,898 oz. silver, and 10,878 oz. gold. The plant is provided with 6 pot roasters, 3 sets of briquetting presses, 7 jacket furnaces, 2 converter stands with hydraulic accumulators, 2 turbo-blowers, and 5 Root's blowers. An electrolytic process has been devised for the recovery of metallic zinc from the mixed sulphide ore and also from the slag, and is reported to be successful.

The Besshi mines and the Shisaka smelter are owned by the Sumitomo Copper Co., of Osaka, and hold fourth place in point of copper production in Japan. The Besshi copper deposit is a bedded vein occurring in crystalline schists of Paleozoic, or possibly of Archean age, and is traceable along the strike for 5000 to 6000 ft. It varies in thickness up to 30 ft. The ore is a massive cupriferous pyrite containing from 4 to 5 per cent. copper, and upon being smelted yields a product singularly free from other metals, so that it commands a high price and needs no electrolytic refining.

A new tunnel is being driven from a point about 1896 ft. below the third tunnel (the lowest drainage level at present) and is in 15,000 ft. and within 4000 ft. of the ore-body. A vertical shaft 20 ft. in diam. for hoisting purposes is being sunk from the third tunnel to meet the new one, and is within 300 ft. of the lower tunnel level.

The Shisaka smelter, located on the Island of Shisakajima, about 15 miles from the terminal of the railroad which transports the ore from the mines to the coast, was built in 1906 at a cost of 4,000,000 yen and is provided with modern equipment. There are in operation at the smelting plant seven 10-ton pot roasters and six blast furnaces. The matte from the blast furnaces, containing 17 to 18 per cent. copper, goes to 58 open stalls, and the roasted matted is smelted in circular crucible furnaces and finally finished in eight reverberatories. The product is blister copper averaging 99.8 per cent. copper tener. The coke needed in smelting is made in ovens at the plant, said to have a capacity of 250,000 tons of coal a year.

The output of the smelter in 1914 was 16,690,040 lb. of copper. On account of smoke troubles the production has had to be restricted during the season that the rice plants are in bloom, and to overcome this hindrance a sulphuric acid plant of 600,000 lb. yearly capacity is being built, and it is expected that the first quarter of the plant will be completed in the coming spring. Basic sulphide ore will be used for the acid manufacture, and fertilizer will be one of the by-products.

Electrolytic copper is produced at five different plants in Japan, namely: the Nikko works, the Kosaka, Hidachi, Mitsubishi, and the Osaka refineries. The monthly capacities of these plants are 2,700,000, 1,600,000, 2,400,000, 2,240,000, and 530,000 lb., respectively.

The export of copper from Japan during 1914 has diminished slightly from that of the previous year, probably owing to the fact that there is a growing demand within the home country for copper for manufacturing purposes. The following table shows the exports to Europe, Asia, and America during the last 10 years.

COPPER EXPORTS OF JAPAN
(In tons)

	Europe.	America.	China.	India.	Totals.
1905	2,813	.....	17,242	52	20,107
1906	23,997	3,628	5,757	82	33,464
1907	13,670	3,569	14,002	410	31,651
1908	25,000	5,515	2,220	2,766	35,501
1909	22,170	9,528	1,589	2,088	35,375
1910	21,116	8,846	957	4,218	35,137
1911	17,288	11,009	3,688	2,322	34,307
1912	23,351	6,917	7,317	805	38,390
1913	19,843	5,543	13,320	3,574	42,280
1914	19,642	5,207	13,577	3,274	41,700

Mexico (By W. G. Matteson).—The copper production of Mexico has steadily decreased since the series of civil revolutions was initiated, the output for 1914 totaling only 36,337 metric tons, as compared with 58,323 metric tons in 1913 and 73,617 metric tons in 1912. This reduction of 38 per cent. from the production of 1913, and of 50 per cent. from the record production of 1912, is an accurate barometer of the true state of the mining industry, which has progressed continually from bad to worse until it has reached the most chaotic condition in its history, owing to the disagreement and pernicious activities of the various revolutionary factions. Even the mining companies at Pachuca and El Oro which, owing to their centralized location with respect to Mexico City have usually been able to maintain operations in spite of many difficulties, were forced to suspend work during a considerable portion of the year.

Mexico's copper production for 1914 was largely due to activities within the states of Sonora and Lower California where, owing to isolation and proximity to the United States border, interference was not so pronounced.

Lower California.—Operations were maintained in the state throughout the year with practically little interruption, in consequence whereof Boleo registered a satisfactory production.

Sonora.—Although the Cananea Consolidated Copper Co., the largest copper-producing corporation in Mexico, has generally been able to maintain operations in spite of almost insurmountable difficulties, the company was forced to suspend work for some time owing to the destruction of railroad bridges, the subsequent cutting of transportation facilities with the United States, and the lack of responsible governmental authority, followed by numerous strikes on the part of the laborers who sought to take advantage of conditions. For a considerable period only sufficient Mexicans were employed to keep the mines unwatered, while dissenters started serious fires in the Veta Grande and Oversight properties. Differences were finally adjusted the latter part of

July, when the strikers were ordered to return to work or fight, the former alternative being unanimously adopted.

The Moctezuma Copper Co., at Nacozari, continued operations at normal capacity for the greater part of the year, making an admirable showing in the face of the rather unsatisfactory conditions, but in October even this corporation was compelled to curtail operations to 60 per cent. of capacity.

Mining operations show an increase of 500,000 tons of ore in reserve. The Pilares, the main hoisting shaft, was sunk to 1285 ft., and a little work there exposed a considerable tonnage of good average grade ore. The Esperanza and Guadaloupe shafts are down 1266 and 1000 ft., respectively.

The mill produced 120,655 tons of concentrate which, with some slime and other ore, was shipped to the Copper Queen smelter at Douglas. It contained 1006 oz. gold, 435,482 oz. silver, and 32,299,211 lb. copper.

Net earnings totaled $1,189,100, and $1,170,000 was paid in dividends.

The Nacozari Copper Co. was able to continue work on a reduced scale. During one period practically all of the American employees were forced to leave, owing to a promulgated statement of Gen. Carranza.

Cobre Verde, a new copper property 3 miles north of Santa Rosa, made several ore shipments to Douglas during the year. Leasers worked intermittently around Santa Rosa and also throughout the Cananea district. The Minneapolis Copper Co. continued operations on a small scale.

Zacatecas.—The Mazapil Copper Co. remained idle during the entire year. Owing to the activities of the various factions in Zacatecas, this rich company with valuable copper, silver, lead, zinc, and pyrite mines at Aranzazu, San Eligio, and Concepcion del Oro has been forced to suspend work indefinitely.

Puebla.—The Tezuitlan Copper Co., operating in the Tezuitlan district of Puebla, has closed its mines and smelter. The branch railroad to the property has been cut repeatedly.

Chihuahua.—The Corrigan-McKinney properties at Terrazas, Chihuahua, have been idle the greater portion of the year. Operators in the Concheño copper district have been able to work intermittently.

Future Outlook.—Mining activities in Mexico were greatly discouraged by the proclamation of August 20, 1914, issued by Vestusiano Carranza at first chief of the Constitutionalist army. This statement canceled all mining titles obtained during the Huerta administration and decreed that all proceedings relative to the acquisition of mining claims commenced during the Huerta régime to be null and void. Sixty days were granted in which applications for renewal of all procedure previously

taken could be made. The order further stipulated that all payments required by the mining laws of Mexico in connection with mining titles or mining claims must be made again to the present administration. All rights were forfeited by persons who did not comply with the above-mentioned rules before the expiration of the said 60 days, and mining land thereafter was considered as open to denouncement.

The re-payment of mining fees with the changing administrations is not a new form of extortion, having been applied in Sonora in 1913. In order to protect their properties, companies have generally paid double or triple taxes under protest.

The future of the mining industry can not be said to look particularly bright at the present writing. The last disagreement of Carranza, Villa, and Zapata, followed by renewed strife, the enforced operation of some properties for the purpose of providing bullion for the army leaders, the necessity of paying premiums on their own bullion desired to pay off their own employees, the continued issues of paper money in the armies against the silver and gold of the mining companies, and the absolute lack of protection against mob outrages, with no apparent end to the prevailing chaos, has caused the majority of operators and mining companies to despair of economical operation, with a subsequent closing of mines until peace is concluded and protection assured.

Peru.—The production of copper in Peru during 1914 shows a decrease, as compared with the output of the previous year. According to Henry R. Merton & Co., the figures for last year are 23,647 metric tons, as compared with 25,487 tons in 1913. The total amount of ore smelted is estimated at 130,000 tons. During the year the United States received from Peru 44,488,809 lb. of blister copper and 5,680,592 lb. of copper in ore that was treated here. England and France received during the same period 1,962,720 lb. of copper, the total exported to the three countries amounting to 52,132,121 lb., or 23,647 metric tons. The production based on the exports to these countries during the last 2 years is shown in the following table:[1]

COPPER PRODUCTION OF PERU

(In pounds)

	Peru—1913.	Peru—1914.
Blister copper to U. S.	42,667,436	44,488,809
Copper in ore to U. S.	10,089,592	5,680,592
Copper to England and France	3,180,800	1,742,720
Sundries, estimated	250,000	220,000
Totals, lb.	56,187,828	52,132,121
Totals, metric tons	25,487	23,647

The two largest operating companies producing copper are the Cerro de Pasco Mining Co. and the Backus & Johnson Co., and the bulk

[1] *Eng. Min. Jour.*, Revised Statistics, Apr., 1915.

of the output of the country comes from their mines and reduction works. These companies worked at full capacity until the outbreak of the war, when they curtailed their output about one-half. Many of the smaller companies closed down.

Cerro de Pasco in the last half was producing at the rate of about 2,500,000 lb. per month, whereas its properties now have a capacity of over 6,000,000 lb. The company's production in 1914 amounted to about 42,000,000 lb. The capacity of the Cerro de Pasco Co.'s smelter is about 1000 tons per day, which amount is supplied chiefly by the company's mines at Cerro de Pasco and Morococha, supplemented by ores purchased from La Docena and other small producers. The predominating minerals of Cerro de Pasco are argentiferous galena, chalcopyrite, panabase (a variety of tetrahedrite), and sphalerite, with a gangue of clay and quartz. The ores of La Docena are tetrahedrite and enargite with a siliceous gangue, carrying on the average 10.5 per cent. copper, 32 oz. silver, and 0.3 oz. gold per metric ton. The Backus & Johnson Co. in 1914 completed its campaign of improvements, but reduced its output. It now owns a hydro-electric plant of from 3000 to 4000 h.p.

Russia.—The copper production of Russia during 1914, according to Henry R. Merton & Co., was 31,938 metric tons, as compared with 34,316 tons in 1913.

The production of copper according to districts was as follows:

District.	1913		1914	
	Poods.	Tons.	Poods.	Tons.
Ural	997,279	16,085	1,026,723	16,560
Caucasus	619,398	9,990	517,452	8,346
Siberia	346,684	5,591	338,088	5,453
Chemical works and refineries	85,032	1,371	86,397	1,393
Total	2,048,393	33,037	1,968,660	31,752

The works of the Caucasus Copper Co. and the Kwarzchana works of the Siemens Copper Co. have been, since Nov. 4 (old style), in the hands of the enemy. The first ones were producing 18,000 to 28,800 lb. daily, the last one was in course of construction and expected to start operation at the beginning of 1915.[1]

The probable effect of the war on the copper industry of Russia is difficult to determine. It is subject to two influences: first, the great demand from the military point of view, and second, the serious inroads made on the supply of labor for the mines due to the calling of men to the colors. The state of war strikes the industry at a moment when it is in a very unpromising condition. In the past few years copper production of the country has grown surprisingly fast, and it was freely prophesied that

[1] *Eng. Min. Jour.*, Feb. 13, 1915.

the present year would see the end of the importation of foreign copper into the country and the beginning of the exportation of Russian copper abroad. But last year this growth was arrested. The reasons given might be held to be satisfactory, if all true, namely, that a number of companies had stopped production for the purpose of renewing and extending their plants. Unfortunately this view had to be taken, however, with a knowledge that the slackening in progress affected more than one important copper-producing district, and it seemed remarkable that the country's industry should have started marking time just at a period when industry generally in Russia was unprecedentedly good, and the demand consequently a large one and one to be taken advantage of, so that when the inevitable general trade depression should arrive the alterations, admittedly so much required, could be made. A fresh complication, as far as the Caucasus is concerned, has supervened through the military activity of the Turks who, it is reported, have got control of the largest Caucasian copper property, which it is said to be the intention of the Russians to promptly recover possession of, if for no other reason than the desire to deprive the Germans of this source of supply of an article of which they stand in such reported urgent need.[1]

Spain.—The copper output of Spain for the last 4 years is given in the following table:

COPPER OUTPUT OF SPAIN AND PORTUGAL
(Long tons)

	(a) 1911.	(a) 1912.	(a) 1913.	1914.
Rio Tinto	33,385	39,925	36,320	21,515
Tharsis	3,395	3,375	3,220	3,605
Mason & Barry	2,920	3,540	3,135	2,140
Sevilla	1,530	1,390	1,510	.....
Other mines	9,700	10,700	9,650	(b)1,941
Total	50,930	58,930	53,835	29,201

(a) Henry R. Merton & Co.
(b) All from the Cordoba Copper Co.

The total for 1914 as given in the table is incomplete. The estimate by Henry R. Merton & Co. gives the production for the year as 37,099 tons.

Rio Tinto[2]—The report for 1914 of this company, owning the leading copper-producing mine in Spain, shows that the properties were idle during the first few weeks owing to the strike. The men resumed work in February, and operations continued on the normal scale until the outbreak of the war. The loss of the German market for copper and pyrite necessitated a substantial curtailment of the output. The various de-

[1] *Min. Sci. Press*, Jan. 30, 1915.
[2] *Min. Mag.*, 12, 239 (1915).

partments were kept going on the basis of 3 day's work per week, and even then the whole of the mineral raised could not be sold. Since the end of the year, the demand from other than enemy countries has improved, and work has been increased to the basis of 4 days per week. The removal of over-burden from the San Dionisio and South lodes has been continued. The underground development and the new deep-level approaches to the ore-bodies are reported to be well in hand. The sales of copper as metal and in ore were 21,515 tons, as compared with 36,320 tons in 1913, and the average price per ton was £59 9s., as compared with £68 5s. The divisible profit was £899,939, as compared with £1,673,372. Out of the profit £81,250 was paid on the 5 per cent. preference shares, and £656,250 on the ordinary shares, being at the rate of 35 per cent. A year ago the ordinary shareholders received £1,406,250, the dividend being at the rate of 75 per cent.

OUTPUT OF RIO TINTO MINES
(In long tons)

Year.	Pyrite for Shipment.	Ores for Local Treatment.	Total Mined.	Average Copper Contents, Per Cent.	Copper Produced at Mines.	Pyrite Sold.	Washed and Other Sulphur Ores Sold.
1903	688,919	1,229,619	1,918,538	2.390	21,565	667,748	118,174
1904	672,344	1,276,475	1,948,819	2.340	21,218	663,744	157,810
1905	627,336	1,202,768	1,830,104	2.363	19,530	660,724	308,184
1906	655,328	1,268,388	1,923,716	2.411	21,287	632,307	477,843
1907	641,858	1,265,090	1,906,948	2.417	21,251	607,944	619,814
1908	604,275	1,115,610	1,719,885	2.265	24,256	589,815	668,477
1909	604,799	1,184,188	1,788,987	2.349	24,364	600,946	569,604
1910	637,020	1,509,945	2,146,965	2.097	22,790	578,443	683,605
1911	649,215	1,536,390	2,185,605	2.144	21,880	662,259	841,964
1912	698,399	1,708,573	2,406,972	2.180	25,623	668,861	977,812
1913	652,168	1,207,403	1,859,571	2.190	21,062	635,900	825,408

Cordoba.—This company was formed by John Taylor & Sons in 1908 as a consolidation of the Cerro Muriano and North Cerro Muriano companies, operating copper mines in the south of Spain, 10 miles north-east of the city of Cordoba. Dividends were paid for the years 1912 and 1913. The report for the year 1914 shows that the grade of the ore has become lower, and during the 7 months before the war the average monthly output of blister copper was only 228 tons, as compared with an average of 290 tons during 1913. On the outbreak of the war, the sale of the copper was interrupted, so that mining and smelting had to be suspended. Subsequently conditions changed, and smelting was gradually resumed, until an output of 150 tons per month was attained. The ore raised during the year was 87,870 tons, averaging 2.78 per cent. copper. The yield of blister copper was 1941 tons. During 1913 the output of blister copper was 3500 tons, and the ore mined was 119,069 tons. The ore reserve on December 31 was estimated at 155,270 tons averaging

2.87 per cent. copper, as compared with 206,489 tons averaging 3 per cent. at the end of 1913 and 200,025 tons averaging 3.35 per cent. at the end of 1912. As has previously been recorded, the Murex wet magnetic process was adopted at the mine a few years ago. During 1914 this plant treated 17,435 tons of middling and slime averaging 1.14 per cent. copper, for a yield of 1232 tons of concentrate averaging 9.5 per cent. copper. The assay of the tailing was 0.49 per cent. copper, and the recovery was 58.8 per cent.

Tharsis.—This company, with headquarters in Glasgow, operates the Tharsis and Calanas sulphur and copper mines in the south of Spain. As the pyrite is shipped chiefly to England and Scotland, no great inconvenience has been experienced from the war. But the low price of copper adversely affected the profits. The shipments of pyrite amounted to 501,037 tons, as compared with 508,287 tons in 1913, and, in addition, 1611 tons of copper precipitate was shipped, as compared with 1534 tons in 1913. The total production of refined copper from pyrite and precipitate was 3605 tons, as compared with 3218 tons in 1913, though the increase was more than accounted for by purchases of precipitate.

Mason & Barry.—This company was formed in 1858 to acquire the San Domingos sulphur and copper mine at Mertola, Portugal, just over the Spanish border, on the same mineral belt as the Rio Tinto and Tharsis. In the year 1878 the company was expanded and public subscriptions invited. At the outbreak of war, the German market for pyrite used in sulphuric acid manufacture was lost, and the output was consequently restricted. The report for the year 1914 shows that 259,238 tons of ore was raised, as compared with 378,929 tons the year before.

Venezuela.—The production of copper in Venezuela is not separately reported and has been small in recent years, but prospects for the future seem encouraging. Only ore averaging about 8 per cent. copper is sent to Europe for treatment, but provision has lately been made for the erection of a smelter to treat the low-grade ore, which will increase the output considerably.

The South American Copper Syndicate, operating the Aroa group of mines, started its new smelting plant in the spring of 1914, but the preliminary difficulties incident to starting the new works carried the company operations into the period affected by the war and the year was not a prosperous one, as production was then reduced to a minimum. Besides the old Aroa mine, the company was preparing to stope ore in the Aroa North and the Titiara mines. In the latter half of the year mining was restricted to a production just sufficient to pay for the operations. The Cumaragua company, of Caracas, continued the

exploration of its group of mines in the Aroa district, power drills having been installed; the old copper mines at Buria, near Nirgua, were also under development.[1]

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